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OLIGOCHAETA

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A MONOGRAPH OF THE ORDER OF OLIGOCHAETA

BY

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PREFACE

THERE are already two works dealing with the Order Oligochaeta. The first of these, in time of publication, is Professor Franz Vejdovsky's 'System und Morphologie der Oligochaeten,' which appeared in 1884. Six years later Professor Léon Vaillant contributed to the volumes on the Annelids of the 'Suites à Buffon' a volume and a half dealing with the same group. It might appear, therefore, at first sight, that the ground has already been taken up, and that there is no occasion for the present work. It must be recollected, however, that it is nearly ten years since the publication of Professor Vejdovsky's treatise, and that during this period our knowledge of the Oligochaeta, more particularly of the earthworms, has increased enormously. Professor Vejdovsky's object, moreover, was more especially to give an account of the structure of the group from his own observations, and to spend less time in dealing with the results of other observers—not that the previous work upon the group was by any means neglected by him, but no great amount of detail was given as to the genera and species of Oligochaeta not occurring in his native country.

M. Vaillant's work is rather more comprehensive in scope, but there is no account of any researches made after the year 1886; so that the large amount of literature which has appeared since that date has not yet been incorporated into any general work. M. Vaillant's contribution also is rather more devoted to the systematic side of the subject than to the description of structure.

Under these circumstances it appeared to me that there was room for a treatise of rather wider scope than those of either Professor Vejdovsky or

of M. Vaillant, and one which should deal with the entire subject up to the date of publication. As will be seen from the bibliography which I have given in the Appendix, the literature of this subject is large and scattered; so that to bring together under one cover all of importance that is as yet known about the group of the Oligochaeta will possibly be considered not to have been a useless performance. In attempting this labour I have received much kindly encouragement from Professor Ray Lankester, which I gratefully acknowledge. I have been so fortunate, through the kind influence of Dr. Burdon Sanderson, as to secure the assistance of the Clarendon Press, to the Delegates of which institution I wish to express my great indebtedness. The cost of the necessary illustrations, which has been considerable, has been largely defrayed by the generosity of Mr. J. P. Gassiot, F.Z.S., who, at the suggestion of Mr. Sclater, has placed a sum of £100 at my disposal for this purpose. Without this very liberal act of assistance on Mr. Gassiot's part this work could hardly have been undertaken.

I may now say a few words about the scope of this monograph. The study of the group with which it deals is one which has occupied my leisure-time for the past fifteen years; I have had the opportunity of dissecting and examining most, if not all, of the more important types; so that while a good part of the volume is necessarily derived from compilation, a considerable proportion of it is the result of first-hand knowledge. Whilst I have amalgamated my recent papers into the present work, I have also incorporated with it a certain amount of new matter which I have not published elsewhere, and I have given, in the systematic part, descriptions of a few new species. I have not, however, made any lengthy investigations for the express purpose of this monograph, but I have in several cases verified the statements of others, and have corrected, in a few minor particulars, errors of observation on the part of myself, as well as of other zoologists. Those who have not followed closely the progress of knowledge in this group of animals may be surprised at the large number of pages which it has taken me to set down the facts: I have erred, however, rather on the side of compression and omission than on that of undue prolixity. The omissions (with a few exceptions to be noted immediately) will not be found, I trust, to be of facts of much importance. They chiefly concern the progress of our

acquaintance with the group. It has not appeared to me to be necessary to go at great length into the history of erroneous views or of misstatements of fact—at any rate compression and omission here seemed to be more permissible than in other departments of the subject. I have deliberately omitted to give any account of the early stages of the development of the Oligochaeta; the development of organs will be found treated of to a certain extent. I determined to do this principally on account of Prof. Vejdovsky's recently published 'Entwickelungsgeschichtliche Untersuchungen,' an elaborate and finely-illustrated work, which goes into the matter with all details, and treats of the rest of the literature in a most thorough fashion. Moreover, I have personally no first-hand acquaintance with the early development of the Oligochaeta—another circumstance which leads me simply to refer to the work already quoted those who are desirous of ascertaining what is known about the embryology of the Oligochaeta. Another branch of the subject which I have thought it well to abridge is the section dealing with unrecognizable species. No name, I hope, has been omitted, and no reference; but I have not, except in a few instances, gone at any length into the endless possibilities as to the identity of species imperfectly described and now irrecoverable.

While this work was in preparation two excellent revisions of two families of the Oligochaeta have appeared: I refer to Dr. Rosa's detailed account of the Lumbricidae, and to Dr. Michaelsen's 'Synopsis' of the Enchytraeidae. The appearance of these two valuable papers caused me to hesitate a little before dealing with the respective families in this work. I have, however, thought it best to incorporate both of them, not, I hope, without critical examination.

In the preparation of the systematic part of this monograph I received the greatest assistance from M. Vaillant's work; I gladly acknowledge that it formed the basis of my preliminary (manuscript) account of many of the species of Oligochaeta, and that it has saved me a vast amount of labour in compilation; I believe, however, that I have nowhere followed M. Vaillant's descriptions and synonymies without careful verification and criticism.

In the general sketch of the structure of the group I have only dealt with generalities; the details of particular genera, or it may be of species,

will be found under their respective headings. My own experience is that in reading elaborate monographs the multiplicity of details tends to throw one off the main course of the argument. Details of minor importance are much better referred to their proper place instead of being included in one long dissertation on the structure of the group. I have therefore attempted to give in my introductory chapter such an account of the anatomy of the Oligochaeta as may be sufficient to satisfy any person not interested in the minute details, but desirous of having the main facts stated in as few words as possible. It may be thought that I have erred in the brevity of this chapter: I claim, however, to have put before the reader a more complete account of the structure of the group than can be found in any treatise yet published, and I have done my best to avoid details not of special significance except as generic or specific characters.

In the systematic part I have not treated each family in a precisely similar fashion. In the Perichaetidae, for example, the internal structure is dealt with after the definition of the family; in the Geoscolicidae, anatomical details are reserved as generic characters. In the highly peculiar group Eudrilidae the method adopted is somewhat intermediate. In each case the plan followed is not, as might perhaps be suspected, the result of the discontinuous preparation of this monograph, but has been deliberately selected as being, in my opinion, most appropriate to the family in question.

For material used in the preparation of this work I am greatly indebted to Dr. Benham, Prof. Claus, Mr. W. T. Thiselton-Dyer, C.M.G., F.R.S., Mr. Chamberlain, Mr. Gustav Eisen, Mr. Everett, Mr. F. Finn, Dr. Gregory, Prof. Lovèn, Dr. Michaelsen, Prof. M'Intosh, F.R.S., Mr. Alvan Millson, Prof. T. J. Parker, F.R.S., Prof. Poulton, F.R.S., Dr. D. Sharp, F.R.S., Mr. W. W. Smith, Mr. Sowerby, Prof. Baldwin Spencer, Prof. Vejdovsky, the Rev. H. W. Woodward, the St. Petersburg Museum, and the Zoological Society of London.

FRANK E. BEDDARD.

LONDON, *February*, 1895.

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Fig. 2. *Perichaeta everetti.*

Ventral view of anterior segments. *sp*, spermathecal pores; ♀ oviducal pore; ♂ male pores.

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Ventral view of anterior segments. ♂ male pore; *sp p*, pore of spermathecal sac.

Fig. 4. *Octochaetus multiporus.*

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♀ female pore: ♂ male pore.

PLATES II AND III.

Generative organs of various types of Oligochaeta diagrammatically represented. The male organs are coloured pink, the female blue. To all the figures the following lettering applies: *T*, testes; *F*, sperm-duct funnels; *sp s*, sperm-sacs; *o*, ovary; *od*, oviduct; *e s*, egg-sacs; *os*, spermathecal sac; *sp*, spermathecae; *sp gl*, spermiducal gland.

PLATE IV.

Fig. 1. *Libyodrilus.*

Dissection. *o*, orifice of spermathecal sac; *sps*, sperm-sacs; *sp gl*, spermiducal glands; *vv*, ventral blood-vessel; *dv*, dorsal blood-vessel; *n*, nephridia.

Fig. 2. *Siphonogaster millsoni.*

Tr, penial (?) processes.

The remaininug figures bear a legend. In all of them the following is the significance of the letters: *g*, gizzard; *ca*, calciferous glands; *sp*, spermathecae; *sp s*, sperm-sacs; *h*, 'heart'; *sp gl*, spermiducal glands; *vd*, vas deferens; *od*, oviduct.

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Fig. 3. *Eudriloides cotterilli.*

Transverse section. *sps*, spermathecal sac with appended glands (*gl*). *dv*, dorsal vessel; *ca*, calciferous glands; *i*, oesophagus.

Fig. 4. *Stuhlmannia.*

Section through penial process. *gl*, glandular epithelium of penis; *m*, septum dividing its cavity from general coelom; *vd*, vas deferens; *n*, nerve-cord; *dv*, dorsal vessel; *I*, intestine; *cl*, clitellar epithelium; *sps*, sperm-sacs; *p*, muscular sac opening at end of penis.

ERRATA

p. 183. To synonyms of *Aeolosoma hemprichii* add *Aeolonais hemprichii* and *Aeolonais decorum* of GERVAIS.

p. 184. To synonyms of *Aelosoma quaternarium* add *Aeolonais quaternarium* of GERVAIS.

p. 214. To synonyms of *Lumbriculus variegatus* add *Tubifex gentilinus*, DUGÈS (fide VAILLANT).

p. 229, l. 14. For *Telmatodrilus* read *Telmatodrilini.*

p. 251, l. 24. For *bogdunovii* read *bogdanovii.*

p. 266, l. 13. For *Hemitubifex ater* read *Hemitubifex benedii.*

p. 275. To list of genera of Naidomorpha add *Ripistes.*

p. 285, l. 4. For *O. josinae* read *N. josinae.*

p. 288, l. 12. For *P. elinguis* read *N. elinguis.*

p. 313, l. 15. For *vermiculus* read *vermicularis.*

p. 332, footnote. For *M. fusca* read *M. semifusca.*

p. 348, l. 15. For *E. hegemon* read *F. hegemon.*

p. 394. A few species (10) have been accidentally omitted from the list.

p. 481. To synonyms of *Fletcherodrilus unicus* add *Cryptodrilus pelewensis*, MICHAELSEN.

p. 498, l. 13. For *C. gravidis* read *C. grandis.*

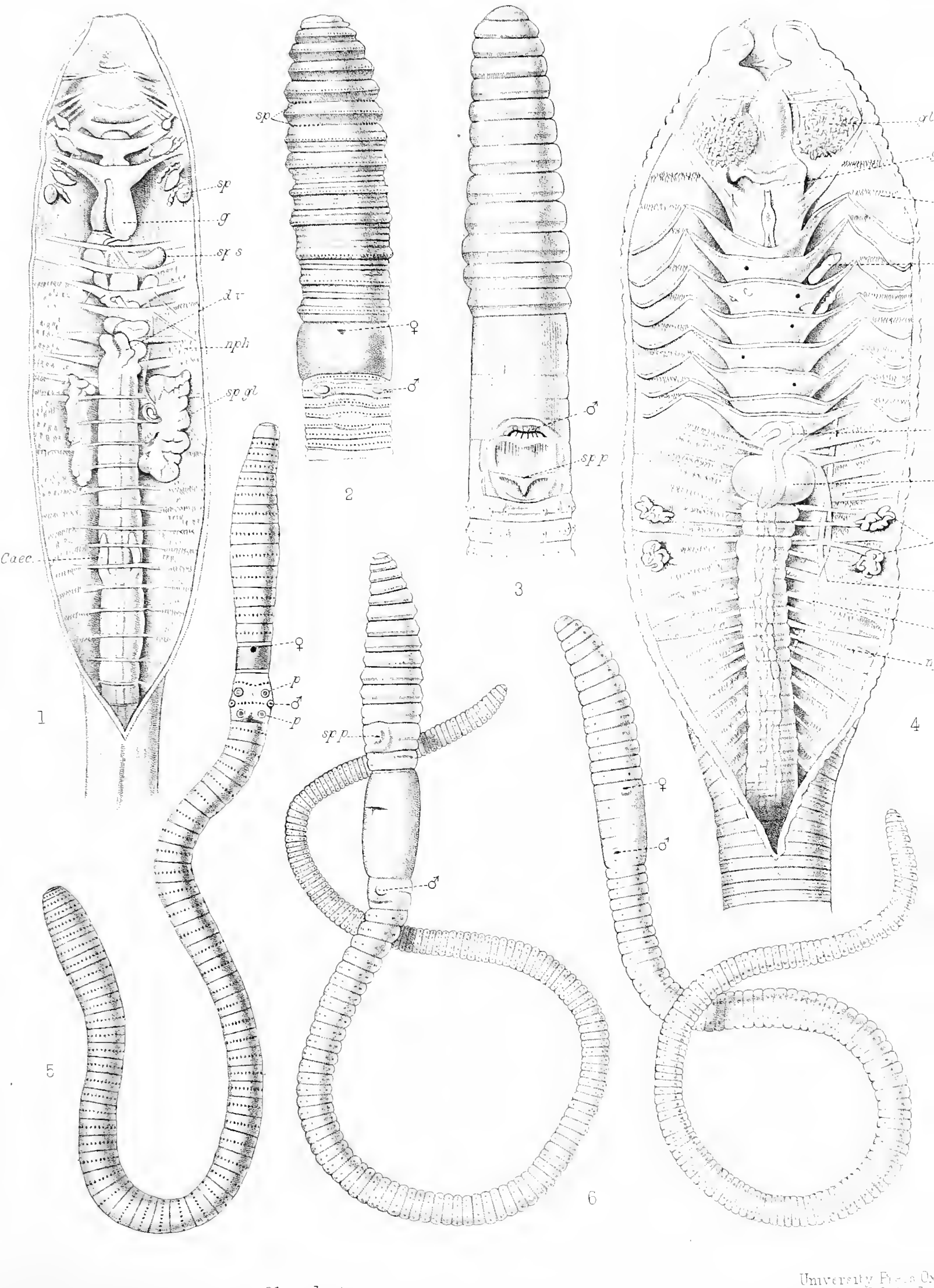
p. 530, l. 18. For *A. communis* read *D. communis.*

p. 552, last line. For *A. multiporus* read *O. multiporus.*

p. 608, l. 23. For *P. elongatus* read *P. finni.*

p. 661, l. 29. For *U. papillata* read *U. papillifer.*

NOTE.—Formal descriptions of *Brachydrilus, Megascolex hallii,* and of *Perichaeta dubia,* have unfortunately slipped out. But the principal facts in the anatomy of these species will be found scattered through the volume, and can be referred to from the Index.



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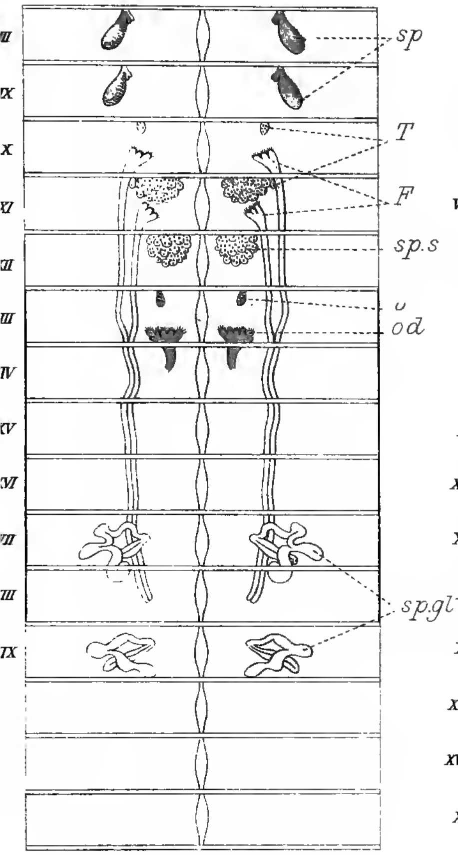

Acanthodrilus.

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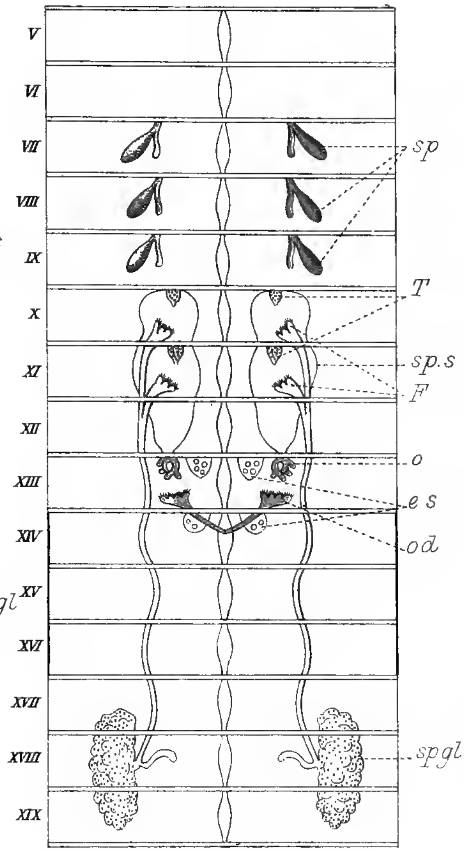

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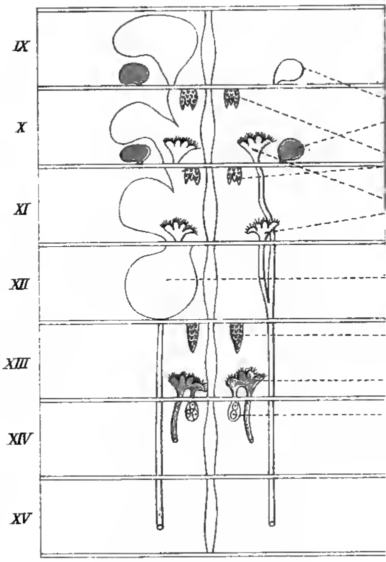

Lumbricus

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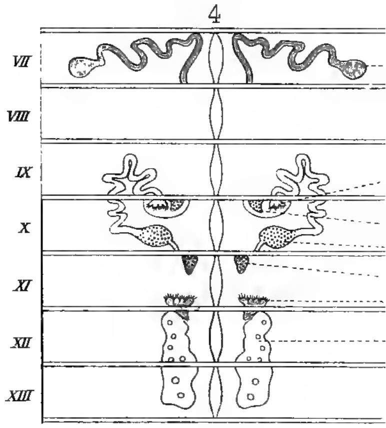

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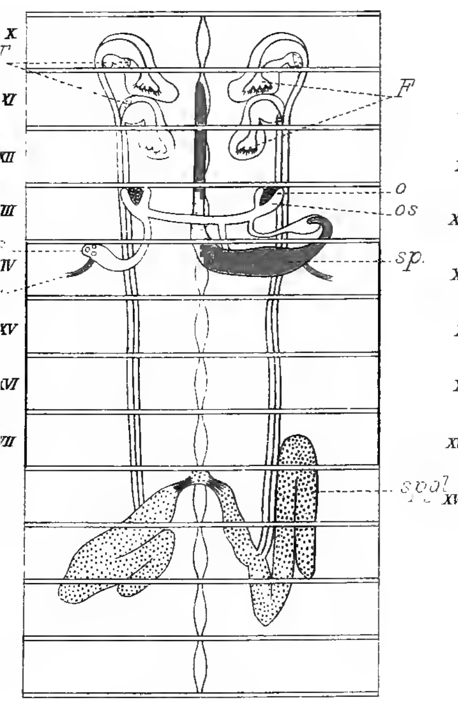

Heliodrilus

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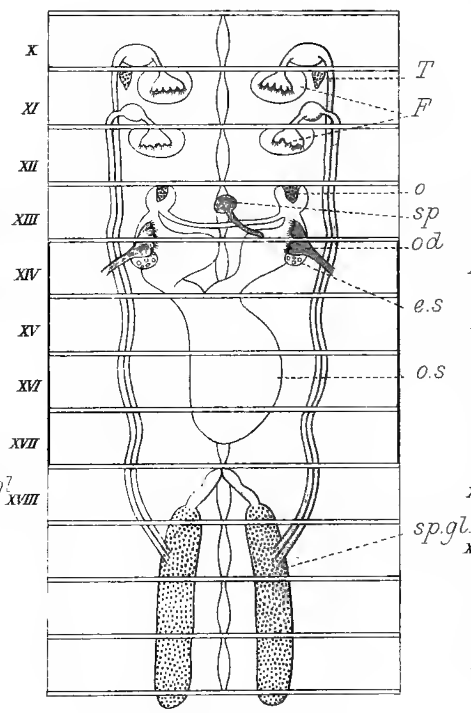

Hyperiodrilus

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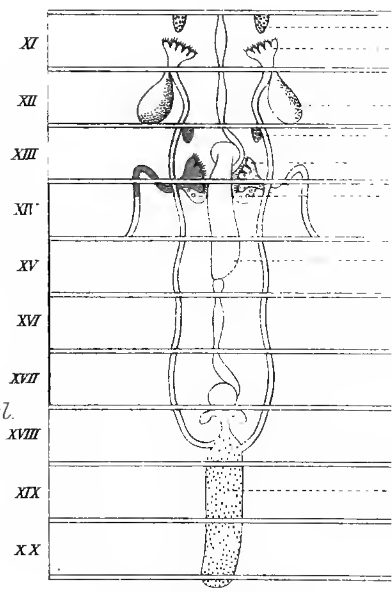

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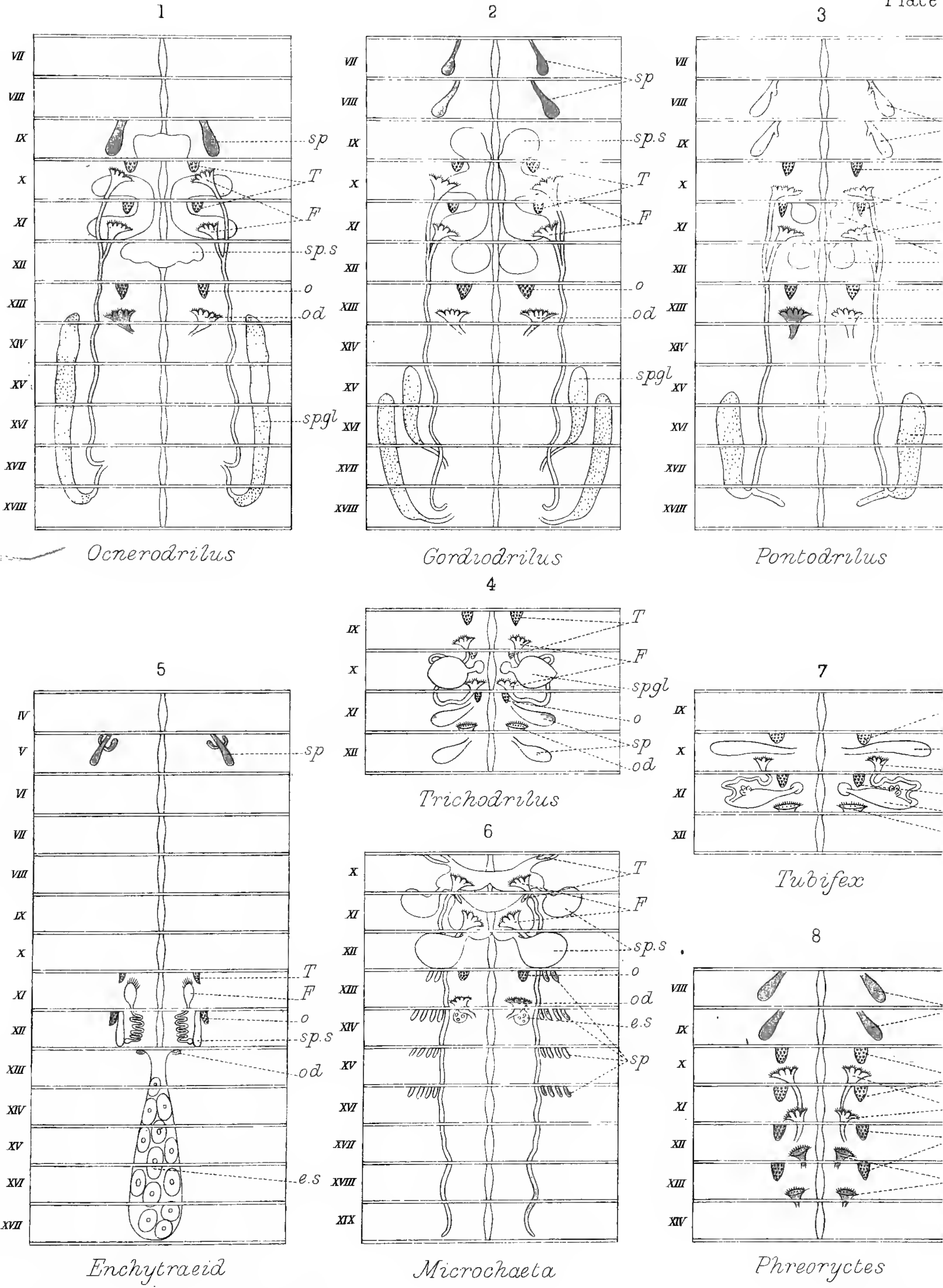

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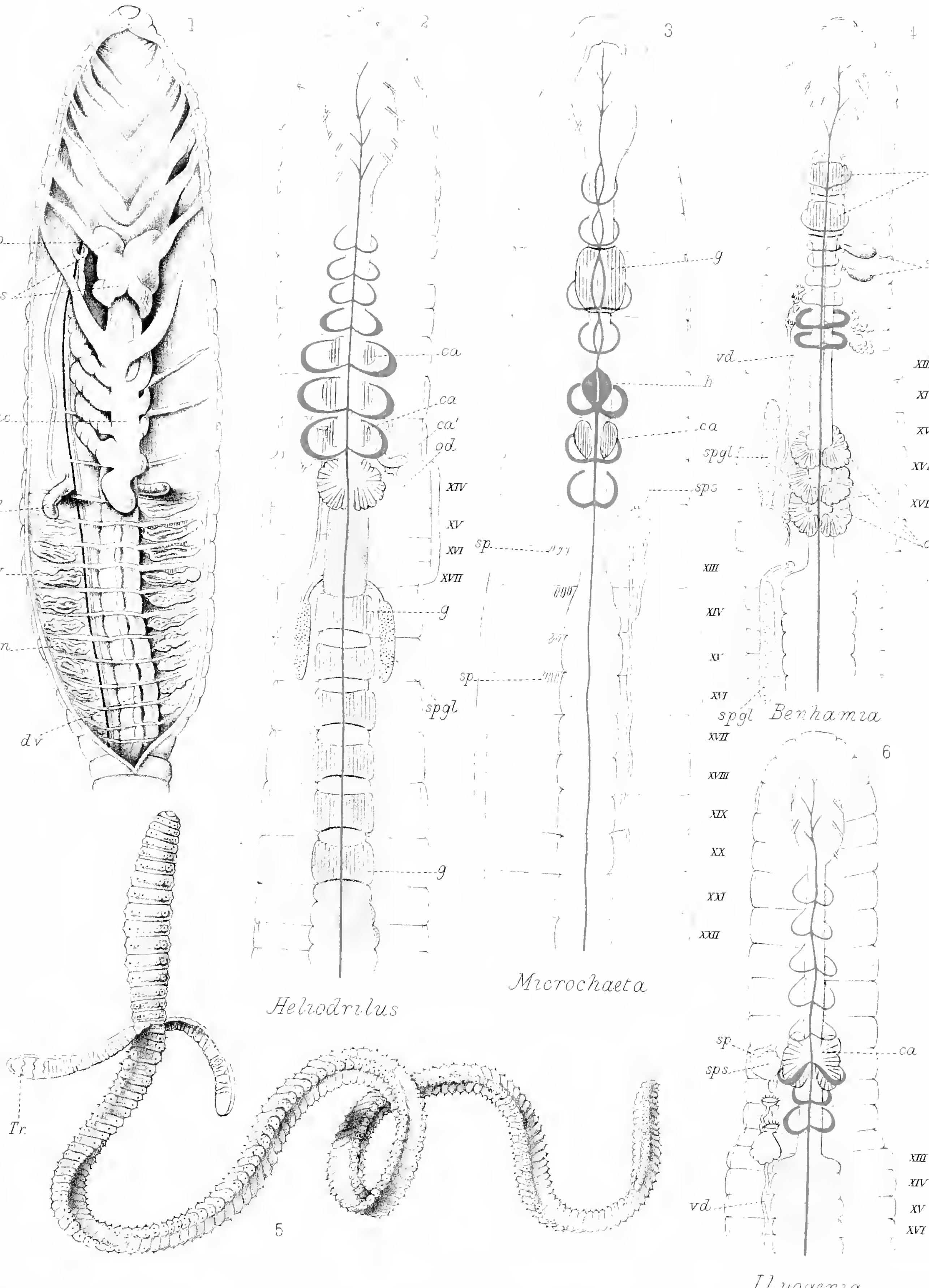

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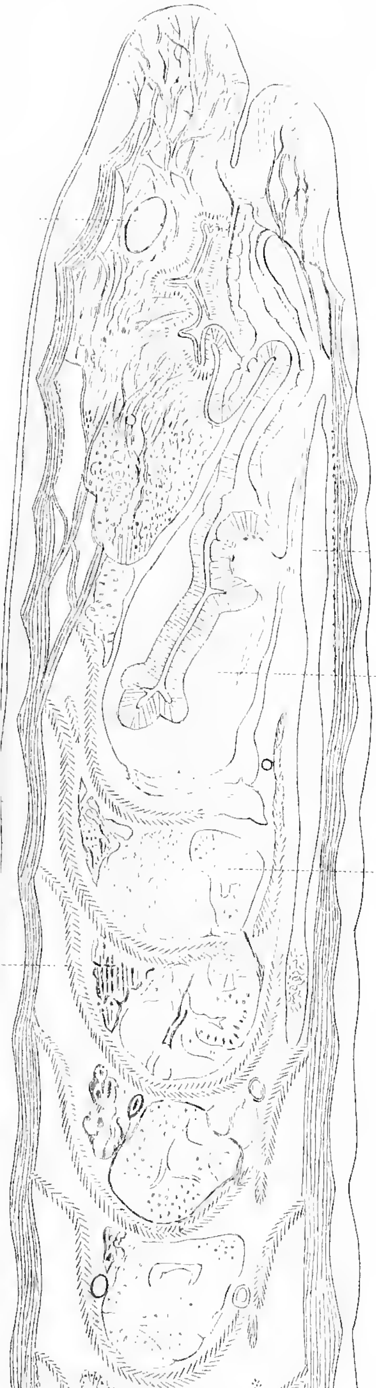

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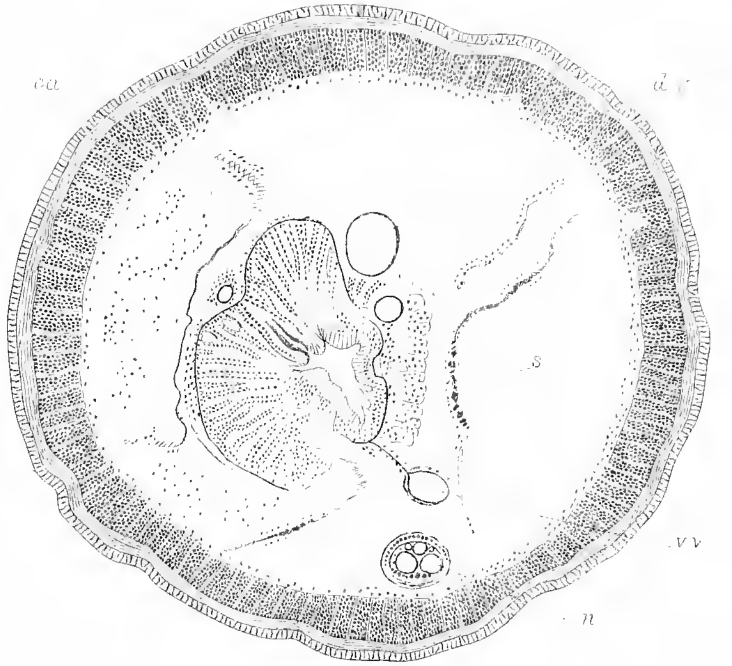

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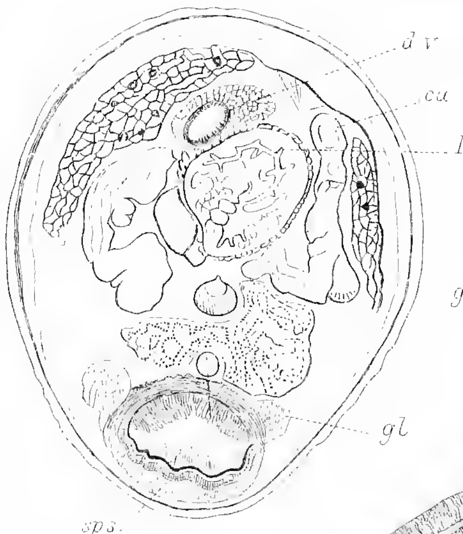

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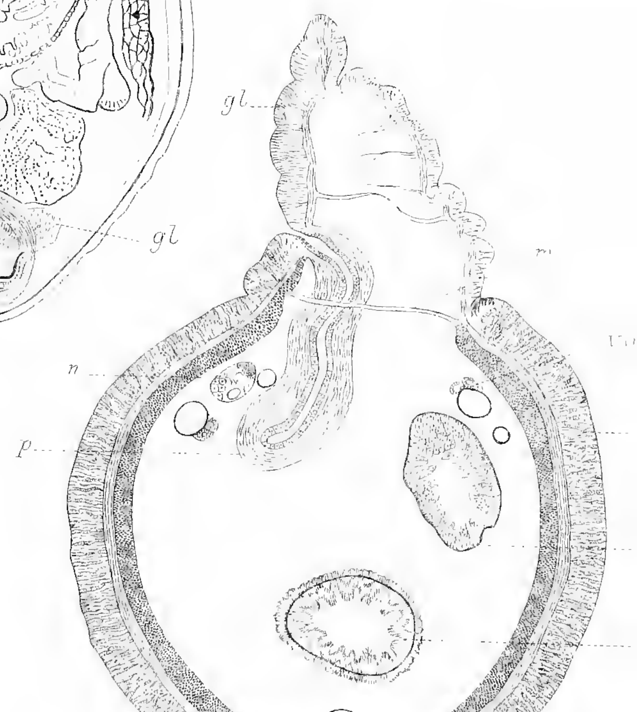

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A MONOGRAPH OF THE OLIGOCHAETA.

Class OLIGOCHAETA, Grube.

Def. Segmented 'worms' invariably hermaphrodite; all the segments of the body—except the first and occasionally an additional and varying number at anterior end—setigerous, the setae usually *ſ*-shaped but showing variation in form, never borne upon parapodia. Excretory organs paired tubes metameric, or numerous in each segment and dysmetameric. Branchial organs, rarely present. Gonads limited in number (normally never more than two pairs of ovaries and testes); sexual products nearly always matured in special sacs developed from the septa. Special ducts carry off the genital products. Development direct. Terrestrial or fresh water, rarely marine, in habitat.

PART I.

THE ANATOMY OF THE OLIGOCHAETA.

§ 1. *Historical Note.* The Bibliography appended to the present work shows how very recent is our knowledge of the anatomy of the Oligochaeta. Of the exotic earthworms, which form so much the greater portion of the known species, there was absolutely no anatomical knowledge until the publication of Vaillant's memoir upon *Perichaeta* in 1868 (3); all that was known before this date from the contributions of F. S. Leuckart, Rapp, Templeton, and Schmarda relates to little beyond external characters. Perrier's researches, particularly his first memoir (6), gave the first indication of the very great structural variation exhibited by the terrestrial Oligochaeta. Since that date (1871) our knowledge has rapidly accumulated, particularly during the last ten years, by the investigations of Horst, Michaelsen, Rosa and others upon the continent, Spencer and Fletcher in Australia, Eisen in America, and Benham and myself in England.

Before 1868 we were only acquainted with the structure of European Oligochaeta. The common earthworm (represented no doubt by several species) furnished material for a number of investigators;

HOME, LEO, MORREN published their researches, but our present accurate knowledge of that animal may be said to date from the memoir of D'UDEKEM (4), who first discovered the ovaries. Subsequently to that LANKESTER (9), CLAPARÈDE (1), HORST (1), v. MOSJISOVICS (1, 2), CERFONTAINE, and others have dealt with the structure of *Lumbricus*. The aquatic Oligochaeta of Europe were first investigated by O. F. MÜLLER; but D'UDEKEM'S memoir upon *Tubifex*, and those of CLAPARÈDE upon that and other forms, are the memoirs from which our modern knowledge dates. Since the publication of CLAPARÈDE'S two memoirs, the aquatic Oligochaeta have been principally studied by LANKESTER, BENHAM, and myself in this country; on the continent by LEYDIG, DIEFFENBACH, and others; in America by EISEN.

1. THE BODY-WALL AND EXTERNAL CHARACTERS.

§ 1. *External form and segmentation.* The Oligochaeta are segmented worms of very variable size; at the one extreme we have the minute species of *Aeolosoma* and certain Naids, 1 mm. or so in length; at the other the gigantic *Microchaeta rappi* and *Megascolides australis*, which measure from four to six feet.

In all the Oligochaeta, with the exception of *Aeolosoma*, where it is at any rate less marked, the external segmentation corresponding to the internal metamerism is very obvious. The grooves which separate the segments from each other are clearly defined. It often happens however, particularly among the larger earthworms, that there is a 'secondary' annulation of the segments. The term 'secondary' is used, because this division of the segment by transverse furrows into two or more parts appears to have no relation to other organs, whether internal or external; at the same time this annulation of the segments and the number of annuli appears to be fairly constant for the species. The number of segments in the body of the Oligochaeta is very small (6–20) in *Aeolosoma* and some others among the lower forms. As many as 500 or 600 segments have been counted in some of the larger earthworms. There are at present no exact data as to the constancy of the number of segments among earthworms. In all probability the number is not absolutely fixed, but there appears to be a mean for each species round which there is a certain amount of variation. There is but little specialization among the segments of a worm's body; it is an invariable rule that the first segment of the body, and it occasionally happens that a few of the following segments also, are devoid of setae; this 'cephalisation' is dealt with more at length on a subsequent page. As a rule the anterior segments of the body in earthworms are wider and marked by more numerous secondary annulations than those which lie behind the clitellum; the clitellum itself is formed by a specialized set of segments.

§ 2. *Prostomium.* In the majority of Oligochaeta a process of the first segment of the body overhangs the mouth on the dorsal side. In a few forms it is of considerable length,

and no doubt plays an important part as a tactile organ; in the majority of Oligochaeta it is not large, and in a few it seems to be totally absent. This 'prostomium,' 'praestomium,' 'buccal lobe,' or 'upper lip,' as it has been variously termed, is often separated by a furrow from the first segment of the body—the buccal segment, of which it is a process. Sometimes the separation is not marked at all, or hardly marked by two lateral furrows which converge towards the middle line but do not meet. The genus *Lumbricus* (*e. g.*) and a few species of *Acanthodrilus* exhibit a very curious condition of the prostomium; it is separated from the buccal segment by a cross furrow, but from the angles of this arise two longitudinal furrows which end at the posterior extremity of the buccal segment and as it were continue on the prostomium over this segment. The prostomium has in this case the appearance of being a process of the second segment of the body. FRIEND has recorded in *Allolobophora chlorotica* (**9**) a remarkable extension backwards of the prostomium which reaches as far as the end of the fourth segment. This, it should be stated, is not a characteristic of the species in question, but an occasional variation.

The genus *Phreoryctes* has a prostomium which is rather elongated and is divided into two halves by a cross furrow at about the middle of its length. In this particular it recalls the Capitellidae.

An elongated prostomium—longer than in *Phreoryctes*—characterizes *Nais lacustris*. The names *Nais proboscidea*, 'die gezüngelte Naide,' given to it by various writers, are expressive of that peculiarity.

The long prostomium of *Rhinodrilus gulielmi* and of *Trichochaeta hesperidum* has a peculiar structure which has not been described elsewhere.

In the former species, I erroneously stated that the prostomium was altogether absent; it is however present, but at times retracted, so that it is not at all conspicuous; at such times it protrudes from the buccal orifice as a slight conical projection. A prostomium of apparently precisely the same character exists in *Trichochaeta*; in that genus I have investigated its structure and relations by means of sections. It protrudes in a fashion similar to that of *Rhinodrilus* from the mouth, and in sections is seen to arise from a slight invagination of the dorsal wall of the buccal cavity just in front of the brain and at a point posterior to the orifices of the first pair of nephridia. According to VAILLANT the prostomium of *Rhinodrilus paradoxus* is similarly an 'extroversion' of the buccal cavity. It is quite possible that in *Trichochaeta*, when the prostomium is completely everted (necessarily along with the most anterior section of the buccal cavity), it may have the appearance of being merely a process of the buccal segment, and may indeed prove to be morphologically such, and therefore comparable to the prostomium of other worms. In the meantime I am inclined to think that it

is an organ of a rather different nature, possibly comparable to the introvert of the Gephyreans.

In a few earthworms the prostomium seems to be completely absent. PERRIER and I myself did not find any trace of the prostomium in *Pontoscolex*, but HORST has subsequently affirmed its existence. There appears however to be no prostomium in *Deodrilus*. Is the absence of the prostomium to be regarded as an archaic character or as due to degeneration? The two alternative views have been put forward. They depend of course upon the morphological nature of the prostomium, concerning which again there are two current views.

WILSON in his lately published account of the development of the earthworm holds that the prostomium is a segment; the only difference which it shows from other segments is that its cavity is unpaired. WILSON explains this by looking upon it as the terminal segment of a body which represents an elongated ring,—the view in fact that the Annelid's body can be derived from a Coelenterate pulled out lengthwise.

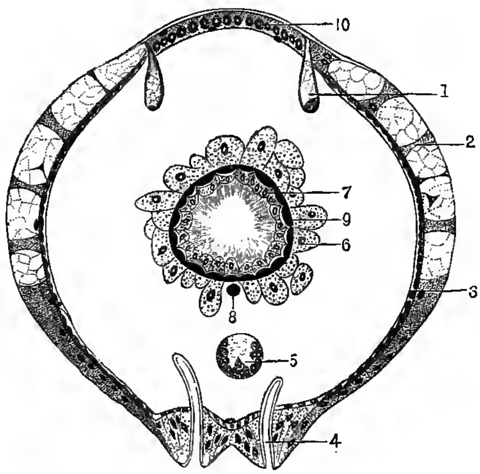
VEJDOVSKY (**9**), on the other hand, found that the prostomium was a comparatively late development—undoubtedly an outgrowth of the first segment. The mouth is originally completely terminal.

§ 3. *External Apertures.* In many earthworms various pores upon certain of the segments are visible; these are (1) the dorsal pores opening into the body cavity, (2) the external pores of the nephridia, (3) and lastly the apertures of the reproductive ducts. The varying position of these pores will be found mentioned under the various organs of which they are the outlets, either in the general part of this work or in the systematic section. A few general observations however may find a place here. The older naturalists used the varying position of these different pores for the purpose of specific and generic definition—usually with questionably useful results; nevertheless it is possible for a person conversant with internal structure to make a pretty accurate guess by the external characters alone as to the genus, or even in a few cases the species, which he is examining. Most conspicuous of all the external orifices are as a rule the male pores; it is only in the Geoscolicidae and in some species of *Lumbricus* that they are not obvious, for the reason that the sperm ducts do not terminate in a spermiducal gland; in *Allolobophora* they are conspicuous, although they do not terminate in such a gland, for the integument is swollen and glandular at their point of opening: in this case the position is always the fifteenth segment; if the pores are obvious and upon the eighteenth segment the genus will be certain to be one of the Cryptodrilidae or Perichaetidae (which can be further differentiated of course by the setae). If the male pores are double and upon segments seventeen and nineteen the worm will be an Acanthodrilid. In all Eudrilidae the male pores are exceedingly conspicuous;

they are in this family nearly always unpaired and median. The pores of the spermathecae are not always so visible; they are however for the most part in the Eudrilidae, where the pore is single and median. The accompanying plate (Pl. I) shows how great the external differences may be between earthworms, though in general shape they are so much alike.

§ 4. *Setae.* In all Oligochaeta, with the single exception of *Anachaeta* (woodcut, fig. 1), there are chitinous rods formed by epidermic cells and arranged in a certain definite plan, which are most usually termed 'setae'; these setae are partly buried in the thickness of the body-wall, and are prolonged into the body-cavity; the free extremity projects for a varying distance beyond the epidermis; the setae are the organs of locomotion of the animals; they are furnished with special muscles which enable them to be retracted or protracted and pulled forwards or backwards; progression is effected by their movements.

Fig. 1.



ANACHAETA BOHEMICA.

(After Michaelsen.)

1. Gland cells = dorsal setae of other forms. 2. Clitellar epidermis. 3. Lateral line. 4. Openings of sperm-ducts. 5. Nerve-cord. 6. Chloragogen-cells. 7. Epithelium of gut. 8. Ventral blood-vessel. 9. Blood-sinus of alimentary canal. 10. Longitudinal muscles.

It used to be believed that the setae were structures of mesoblastic origin; but it is now, through the researches of VEJDOVSKY and others, so firmly established that they are epidermic that it seems to be of no particular use to go into the history of the older and erroneous view. The setae are implanted in sacs which are diverticula of the epidermis; at the margin of these sacs the chitinous cuticle is invaginated and forms a lining for the seta sac down to a certain depth; beyond this the seta is imbedded in a mass of cells, each one of which can produce a new seta to replace the original one. The invaginated part of the epidermis consists of a row of low cells lined by the cuticle already mentioned, and terminating in the mass of cells without cell boundaries in which the seta is firmly imbedded; often, as VEJDOVSKY has figured for *Rhynchelmis,* the sac is reinforced by a second sac lying near to it, also multicellular and containing a seta in course of development. The setae first appear as small cones of chitinous substance; the apex of the seta, its free extremity, is first developed; it then gradually grows in length. A single sac (which it must be remembered is multicellular) often contains, as in the Tubificidae, a large number of setae. The invaginated epidermis does

not always appear to exist; thus in *Tubifex* (NASSE) and *Limnodrilus* (VEJDOVSKY) no such hollow sac is figured; the setae and the solid mass of cells in which they are imbedded reaching right up to the epidermis: in these cases however there seems to be an invagination of the chitinous layer; hence it is possible that a tube of epidermis is also invaginated. CERFONTAINE (**1**) has figured two sections out of a series through a seta sac parallel to the surface of the body; near to the external surface the seta is seen to be surrounded by a tube whose walls are composed of about fifteen cells; this region is the tubular invagination of the epidermis; further down the number is reduced to four and then to two which are flattened and concave, closely embracing the setae, the special lining of chitin present in the more superficial part of the tube being here absent.

In *Anachaeta*, as has been already mentioned, there are no setae at all; but the recent existence of these structures appears to be shown by the presence of large sacs depending from the epidermis on the dorsal side of the body, not the ventral, or (*Anachaeta eiseni*) on both: these sacs are apparently the equivalents of the seta sacs, and consist of a large cell of a glandular appearance with one or two nuclei near to its free extremity.

The form of the setae in the Oligochaeta is varied; but they may be grouped into two divisions, (1) long slender setae gradually diminishing in diameter towards the pointed extremity, and (2) shorter setae of a curved form, something like an elongated S with a thickening at about the middle; the shape of these setae has been aptly compared to that of the mathematical sign ∫. The capilliform setae only occur in the aquatic Oligochaeta, and not in all of them.

The sigmoid setae vary very much in the details of their shape. The simplest form is that which characterizes the vast majority of earthworms, the Phreoryctidae and many Lumbriculidae. These setae end in a pointed extremity. In *Onychochaeta* the extremity (fig. 2 *a*. 1) may be markedly hooked. In *Pontoscolex* among earthworms, in certain Lumbriculidae, in all Tubificidae and Naidomorpha the sigmoid seta is cleft at the free extremity (woodcut, fig. 2 *b*. 4). A further complication is seen in *Tubifex* and other Tubificidae, where there are a few subsidiary prongs arising between the two main prongs into which the extremity of the seta is cleft (woodcut, fig. 2 *b*. 6); this later form of seta may be termed 'pectinate,' the simply cleft seta 'uncinate.' A remarkable variation characterizes *Heterochaeta*, and to a less extent *Psammoryctes* and *Spirosperma* (woodcut, fig. 2 *b*. 3), where the widely divergent prongs are united by a ribbed membrane. This form of seta has been termed 'palmate.' Another form of the uncinate seta characterizes certain Naidomorpha. The seta (woodcut, fig. 2 *b*. 7) is straight instead of being curved, and has a cleft extremity. This form is termed

'hastate.' The Enchytraeidae show another form of sigmoid seta which is nearly perfectly straight but has not a cleft extremity.

Another modification of the sigmoid seta is especially characteristic of the family Geoscolicidae among earthworms, though not unknown elsewhere. The end of the seta, which protrudes from the body, is ornamented (woodcut, fig. 2 *a*. 2, 3) with transverse ridges (*Pontoscolex*) or with minute spinelets (*Trichochaeta*).

The capilliform setae, (fig. 2 *b*. 2) which are exceptionally (*Lophochaeta*) covered with fine processes (woodcut, fig. 2 *b*. 5), comparable perhaps to the ornamentation of the sigmoid setae in *Trichochaeta*, to some extent graduate into the sigmoid setae. The intermediate condition is seen in *Phreodrilus*, where the capilliform setae are shorter, stouter, and more curved than in other Tubificids. As *Phreodrilus* is in other respects a link between the Tubificidae and Lumbriculidae, the fact gets an additional interest.

It sometimes happens that a worm has setae of one kind only from head to tail. This state of affairs however is the less usual. Among the aquatic forms certain species of *Aeolosoma*, and of the Tubificidae (*Limnodrilus*), Enchytraeidae, and Lumbriculidae, are the only instances. Among earthworms the Moniligastridae, many Megascolicidae, and some Lumbricidae and Eudrilidae are examples.

The commencement of a diversity in the form of the setae is seen in *Phreoryctes*, where some of the setae are longer than the others—the dorsal longer than the ventral, or *vice versa*, or the posterior longer than the anterior; in many Perichaetidae the ventralmost setae are longer than the others; in some those upon a few of the anterior segments are longer than the rest.

Fig. 2 *a*.

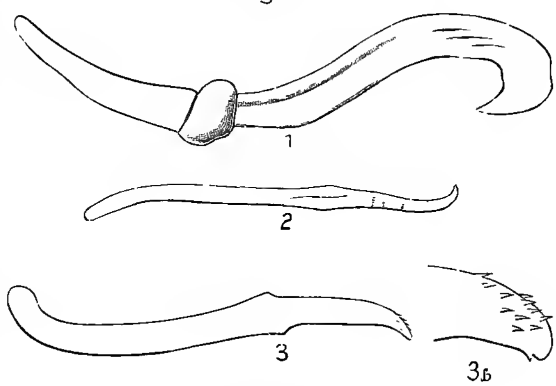
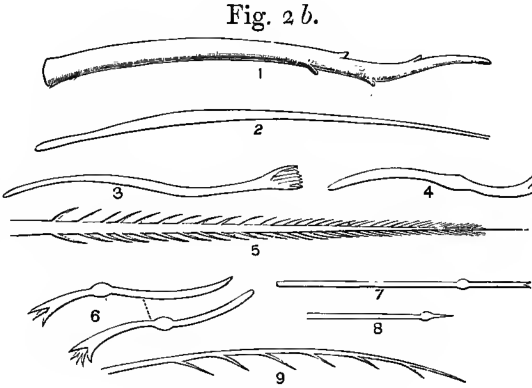


Fig. 2 *b*.



SETAE OF OLIGOCHAETA.

(After Vejdovsky, Stolc, Michaelsen.)

Fig. 2 *a*. 1. *Onychochaeta windlei*: posterior seta. 2. Ornamented seta of Geoscolecid. 3. *Trichochaeta hesperidum*. 3 b. End of same more highly magnified.

Fig. 2 *b*. 1. Penial seta of *Acanthodrilus georgianus*. 2. *Spirosperma ferox*. 3. *Spirosperma ferox*. 4. *Ilyodrilus coccineus*. 5. *Lophochaeta ignota*. 6. *Tubifex rivulorum*. 7. *Nais elinguis*. 8. *Nais elinguis*. 9. *Bohemilla comata*.

Another stage is seen in many Geoscolicidae and Lumbricidae, where the setae upon the clitellum are longer than the others and of a slightly different shape; it occurs for example sometimes in the Geoscolicidae that the clitellar setae are ornamented, while those formed elsewhere are not. In the Eudrilidae the setae are apparently similar throughout the body except in the neighbourhood of the male pore. These penial setae (*see* under description of reproductive system) occur in many Oligochaeta.

It is however among the aquatic genera that the greatest specialization of the setae occurs. Among earthworms a single segment has never setae differing in *form* though they may differ in size, excepting only in the case of the segments which bear the specially modified penial setae, which may be a little different among themselves and are as a rule very different from the ordinary locomotive setae on the same segment. But the rule among aquatic Oligochaeta is that the dorsal bundles of setae should contain setae different in form from those of the ventral bundle. In most Tubificidae the dorsal bundles are made up of capilliform setae, with which may or may not be mixed uncinate setae; the ventral bundles are entirely composed of the latter. The details in the distribution of the setae, which are most useful for classificatory purposes, will be found in the systematic part of this work.

The arrangement of the setae among the Oligochaeta is varied. The most prevalent plan is the existence of four groups of setae, which of course recall the parapodia of the Polychaeta. The principal ways in which the setae are disposed are indicated in the following table:—

1. Setae numerous in each segment and forming a complete ring.—Ex. *Perichaeta, Pleionogaster*, and other Perichaetidae.

2. Setae numerous but arranged in two lateral masses leaving dorsal and ventral gaps.—Ex. *Megascolex.*

3. Setae twelve in number in each segment.—Ex. *Deinodrilus.*

4. Setae eight in each segment placed at equidistant intervals or grouped into four pairs, or intermediate, four setae being paired and four distant.—Ex. *Acanthodrilus*, *Lumbricus.*

5. Setae eight in number in anterior segments, and thence increasing to thirty or forty.—Ex. certain Perichaetidae.

6. Setae in four bundles with more than two setae in each bundle.—Ex. Tubificidae.

7. One pair of setae only on each side of segments.—Ex. *Anachaeta.*

8. Setae, eight in number in each segment, but irregularly arranged.—Ex. *Diachaeta.*

It will be seen from the above table that there is an almost unbroken series of stages in the arrangement of the setae; we can pass from one extreme to the other without any difficulty; thus assuming for the moment that the original condition is exemplified by

Perichaeta, a gradual reduction in the number of the setae anteriorly leads to certain species of *Megascolex*; a reduction upon all the segments of the body simultaneously leads through *Deinodrilus* to *Acanthodrilus*, &c.; on the other hand, a crowding together of the setae into four bundles coupled with a reduction in numbers, brings about the arrangement characteristic of the Tubificidae.

It is however by no means certain that the stages have been developed in the order suggested above. There appear to be three possible lines of development; either the 'perichaetous' condition is the most primitive, or the two pairs of setae in each segment, or the bundles with several setae (more than two) in each bundle. We shall consider these various possibilities seriatim. If we regard the Oligochaeta as to be derived from the Polychaeta it is clear that the last of the three alternatives is the one which would then appear to be the most probable; the considerable specialisation in the individual setae of a bundle is a further point of resemblance to the conditions characteristic of many Polychaeta. But there is not after all much detailed resemblance between the setae of the Tubificidae and those of the Polychaeta; the fact that in both groups the setae of the dorsal bundles are very often different in form from those of the ventral bundles is perhaps more striking as an analogy than valuable for the purposes of a strict comparison; if the differences were of the same kind it would be different. Still it might be urged that in the Tubificidae there is a resemblance to the Polychaeta toned down by simplification. Furthermore, we have the extinct *Pronaidites*; this worm has been referred to the Oligochaeta (KUSTA), but it is not by any means convincingly an Oligochaet. As the creature is of Carboniferous age, this argument would be strongly supported if it were proved beyond doubt to be referable to the Oligochaeta.

Unfortunately, this is the only piece of palaeontological evidence bearing upon the matter under discussion, and at best it is not conclusive in any direction. Besides, looking at the matter in another light, there are now undoubted Polychaeta known which inhabit fresh water, for example *Manayunkia*. The only families of Oligochaeta which show this resemblance (such as it is) to the Polychaeta in the arrangement of their setae are the Tubificidae, Naididae, and Aeolosomatidae; and they are all, it will be observed, aquatic in habit. Now it seems quite reasonable to suppose that long and delicate setae would be out of place in a worm having to force its way through dense soil; we need not therefore be surprised at not meeting with such setae among the terricolous forms; but there does not appear to be any valid *a priori* reason against finding bundles of short and strong setae in the land Oligochaeta; and yet there are only the Enchytraeids among the terrestrial Annelids with such an arrangement of setae, and they are largely aquatic. One is accordingly inclined to

suppose that after all the bundles of setae have some relation to the aquatic life; it is quite possible that a number of them radiating out in a fanlike way serve as an efficient swimming organ, and hence their development in Oligochaeta which occasionally at least 'swim.' If there were any other reasons for associating together the families of Oligochaeta mentioned with the Polychaeta, this question of the similarity in the disposition of the setae would have to be reconsidered; but it cannot be said that the Tubificidae and the Naids are nearer allies of the Polychaeta than any other families of Oligochaeta; hence I am inclined for the present to put down the likeness in the bundles of setae in the marine and in the fresh water Annelids to a similar need.

Eisig has dealt with this subject in his Monograph of the Capitellidae (p. 574, etc.). In that group there are forms in which the distichous arrangement, obvious elsewhere, is nearly lost; a state of affairs very like that of *Perichaeta* thus results, or more like *Megascolex*, since there are dorsal and ventral gaps. There can be no doubt, in Eisig's opinion, that the later arrangement is secondary, it being restricted to the beginning of the abdomen, and being preceded as well as succeeded by the ordinary paired bundles.

One argument in favour of deriving the fewer setae per segment of most earthworms from the perichaetous condition does not appear to me to have been considered. That argument is based upon the fact that in most Perichaetidae the number of setae is less in the anterior than in the posterior segments of the body. In a number of species, which I formerly proposed to place in a separate genus *Anisochaeta*, there are eight setae in a varying number of the anterior segments, while posteriorly the number becomes much greater; this is an extreme case of the point at issue; but in all Perichaetidae there seems to be a smaller number of setae on the pre-clitellian segments than upon those which follow, or there is a progressive increase for a few segments at any rate. In *Megascolex* this is, so far as we know, invariably the case; but in *Perichaeta* the number, after increasing up to a certain segment (for example the seventh in *P. taprobanae*), diminishes. Now in such a form as *Onychochaeta* the absence of setae upon the first few segments of the body (seen also in other Geoscolecids) must surely be regarded as an instance of what has been called 'cephalisation'; it is at any rate a modification paralleled by other organs of the body. It would seem therefore likely that the smaller number of setae in the anterior segments of the body in the Perichaetidae is due to a reduction from a primitively greater number; as we know that this number is sometimes reduced to eight we have the origin of the eight setae per segment of the majority of the terrestrial Oligochaeta suggested. Such general arguments as can be deduced from

the primitive position of the Perichaetidae among earthworms can also be used; this matter however is discussed later. SPENCER has referred to the existence in *Megascolex* of what would seem to be a regenerating tail; and it is noteworthy that here the setae are more numerous than anteriorly; it suggests a recurrence to an earlier condition. Why the number should have been reduced to eight exactly is a more difficult matter; it is a problem comparable to that involved in the attempted explanation of why earthworms should usually have two pairs of testes and certain species four pairs of spermathecae. There is no obvious advantage to be discerned in either fact.

Typically the setae are repeated from segment to segment, with or without modification in form in different parts of the body or in different regions of the same segment. It sometimes happens, however, that the setae are partially or entirely missing upon certain segments of the body. These segments are either the first few segments of the body or certain of the genital segments. I have already mentioned the entire absence of dorsal setae in *Chaetogaster* and of all the setae in *Anachaeta*.

In the segments which bear the male pores the ventral setae are very commonly absent; this is the case for example with *Dero* and with a good many earthworms (e.g. *Ocnerodrilus*, *Megascolides orthostichon*); in *Psammoryctes barbata* the dorsal setae also of the segment (eleventh) which bears the male pores are absent.

A more remarkable instance of a specialisation of this kind occurs in a large number of species of *Perichaeta*. In those species, for example in the common *P. indica*, the three segments of the clitellum are quite without setae. Various intermediate conditions between the total absence of setae and their presence to the full number are seen in other species. There seems also to be a tendency in other earthworms for the clitellar setae to disappear, though sometimes, as has been already mentioned, the converse occurs, and they become replaced by a series of a different form.

§ 5. *Cephalisation.* LANKESTER has applied this expression to the specialisation of the anterior segments of the body so frequently seen among the Oligochaeta. As already mentioned, all Oligochaeta show cephalisation as regards the first segment of the body, which never possesses setae. There are a few earthworms in which more than the first segments of the body are without setae; these worms chiefly belong to the family Geoscolicidae, and the number of segments which are thus without setae differ in different species. There are as many as twenty in *Kynotus*. The Geoscolicidae are not the only family which show this character; in the genus *Deodrilus*, belonging to the Cryptodrilidae, the first segments are similarly devoid of setae. Among the Naidomorpha, the cephalisation affects the dorsal bundles of setae only; in *Chaeto-*

gaster, however, there are several segments following the first setigerous segment, which have no setae; in the other Naids a variable number of segments, varying with the genus, are without dorsal setae; for the details the reader is referred to the special description of the family. The only other examples among the lower Oligochaeta are afforded by *Enchytraeus monochaetus* and *Hesperodrilus albus*.

The formation of a head or cephalisation is not however confined to the absence, or reduction in number, of the setae. Other organs show analogous modifications. It is common, for instance, to find the intersegmental septa not clearly definable in the first two or three segments of the body; their place is taken or their existence is concealed by masses of muscular fibres which pass from the buccal cavity and pharynx to the parietes. In all Oligochaeta a certain number of anterior segments of the body are without nephridia, or the nephridia if present are modified. There are various other organs which show peculiarities at the anterior end of the body and contribute to the formation of a 'head.'

§ 6. *Epidermis.* The epidermis of all Oligochaeta consists of cells which are separated from the subjacent muscles by 'a condensation of the connective tissue of the latter layer, which presents in parts the appearance of a veritable lamella' (CERFONTAINE). CLAPARÈDE, adopting WEISMANN's term—hypodermis, described this layer in *Lumbricus* as consisting of a nucleated meshwork in which no cell-outlines could be distinguished, enclosing spaces filled with a colourless substance; these bodies were regarded as of a glandular nature, but no nucleus was discovered. LEYDIG's earlier view (**6**), based upon a study of *Phreoryctes* as well as *Lumbricus*, of the cellular nature of the entire epidermis was discarded, except for the prostomium, where CLAPARÈDE detected in osmic acid preparations its cellular character.

This erroneous view appears to have been first rectified for *Lumbricus* by PERRIER (**9**) in a preliminary dissertation upon the structure of that worm, which precedes his account of the anatomy of *Urochaeta*. A few years later the cellular nature of the epidermis was stated by LANKESTER (**12**); he speaks of it as consisting of 'varied forms of goblet cells and, excessively delicate, elongate, interstitial, or "packing" cells, instead of the altogether improbable syncytium of CLAPARÈDE.' These results are mentioned as being confirmatory of those of HORST and V. MOSJISOVICS, which had been published previously. Since that date all observers have agreed in regarding the epidermis as distinctly cellular and built up of the two kinds of cells referred to in the quotation from LANKESTER's memoir.

CERFONTAINE's memoir, published in 1890 (**1**), contains the most detailed account that has yet appeared of the epidermis of *Lumbricus*.

The cells are disposed in two rows, the cells of the innermost row being small.

These latter are pointed at one extremity, the fine process running up between the other cells; these cells are termed by CERFONTAINE 'cellules de remplacement,' inasmuch as they appear to replace the other cells of the outer layer. The outer layer itself is composed of two sorts of cells, of large oval glandular cells and of the interstitial cells; the former are large oval cells filled with numerous granules; the basal portion of the cell. in which lies the nucleus, is more protoplasmic and is narrower than the swollen upper part; the cell ends above in a fine prolongation which opens through a pore on the cuticle. The interstitial cells are of much less diameter; they often appear in cross sections to have excavated surfaces; and in fact they are moulded to the form of the glandular cells which lie amongst them. The distal extremity of these cells is frequently prolonged or rather frayed out into a number of fine processes which seem to be in connexion with nerves. The cells of the epidermis are imbedded in a homogeneous connecting substance, which is more evident where the cells diverge from each other at the point of contact with the cuticle. This connecting substance leaves a polygonal meshwork upon the cuticle, which is visible when the latter is viewed from the under surface. The cuticle seems undoubtedly to be a formation of the packing cells of the epidermis; the pores upon its surface are the outlets of the gland-cells, and their existence appears to be simply due to the fact that the gland-cells do not secrete a cuticle like the other cells, their secretory activity being taken up in the formation of the granules with which they are laden; hence at the points where they abut upon the cuticle there are gaps—the pores in question. The cuticle is sometimes distinctly to be seen as a double layer; viewed superficially it is seen to be traversed by two sets of striae, crossing each other at a right angle; these striae correspond to two sets of fibrils, which are not upon the same plane, and therefore give rise to the double layer already referred to.

The striation is thus not merely an optical effect, but is due to the composition of the cuticle out of numerous fine strands of cuticular substance.

Clitellar epidermis. The epidermis on the clitellum is modified in structure. In *Lumbricus* it has been described, especially by CLAPARÈDE, HORST, MOSJISOVICS, CERFONTAINE, and quite recently by COLE.

The clitellum in the most fully developed portion, that is to say on the back of the animal, is made up of several layers of glandular cells. There are first of all elongated gland-cells of cylindrical form, which are filled with granules, save at the inner extremity which is protoplasmic, and contains the nucleus. These gland-cells do not extend for a great distance into the thickness of the clitellar epidermis; below them are the second sort of cells which are massed together into columns; there are several layers of these cells, and the axes of the columns which they form are

occupied by their processes which extend up to the cuticle. The columns are separated from each other by septa of a kind of connective tissue, which is fibrillated, and ends below upon the circular muscular layer, but not in actual connection with its fibres. In the fully developed part of the clitellum there are no non-glandular epidermic cells; these exist, however, on the ventral surface of the body in the clitellar region.

The epidermis, both clitellar and non-clitellar, of other earthworms seems to be like that of *Lumbricus*, which has just been described. In *Microchaeta*, however, BENHAM has stated that the gland-cells seem to be more numerous than in *Lumbricus;* such also appeared to me to be the case with *Pontoscolex;* the clitellum of *Microchaeta* has been described and figured by BENHAM (**2**). In addition to the layers which have been described above for *Lumbricus*, and which occur in *Microchaeta*, there is an outer layer exactly like the epidermis of the general body-surface; it has not only the interstitial cells which, as already mentioned, occur in *Lumbricus* in the less deeply modified clitellar regions, but also the oval gland-cells; BENHAM does not state from what region of the clitellum his sections were taken. In the lower Oligochaeta there can generally be distinguished the two kinds of cells in the epidermis. In *Enchytraeus möbii* among the Enchytraeidae the gland-cells are not, comparatively speaking, very numerous; in *Phreodrilus* and *Pelodrilus* I (**21**) recognised the same two varieties of cells; in *Aeolosoma* the gland-cells contain a coloured substance which is frequently very characteristic of the species; for example in *Ae. quaternarium* the oily substance is red; in *Ae. headleyi* a bright green; in *Anachaeta bohemica* there are three varieties of the glandular cells, colourless cells which are either elliptical or more spherical in form, and larger cells with green contents, the substance being chlorophyll.

The clitellum in all the lower Oligochaeta shows no great differences from the ordinary epidermis; the same two kinds of cells are present, but the gland-cells are commonly more abundant and larger. The clitellum of the lower Oligochaeta has been described especially by VEJDOVSKY (**24**), but also by others—for instance MICHAELSEN (*Anachaeta*), STOLC (*Aeolosoma*), myself (*Moniligaster*), etc. The morphological difference in the clitellum of the lower and the higher Oligochaeta is duly insisted upon later. In the former, as will have been observed, it is less modified and is only a single layer of cells thick.

Sense organs of epidermis. The cells of the epidermis are in parts modified to form sense organs. It is possible that the fine processes which arise from the epidermic cells in *Aeolosoma* and in many Naids have a sensitive function; but there is apparently no particular modification of the epidermis to be traced in connexion with them, though in *Bohemilla* VEJDOVSKY figures ganglionic enlargements upon twigs which

arise from the cerebral ganglia and end in these processes; however, it is common among the Oligochaeta for the epidermis of the prostomium to be modified to the extent that it has no gland-cells and is formed of deeper cells than is the epidermis elsewhere; in the genus *Aeolosoma* and in the perhaps closely allied *Ctenodrilus* the under side of the prostomium is ciliated and there are a pair of lateral ciliated pits, possibly of a sensory nature. In the Naidomorpha we meet with the definite sense organs possibly of a tactile nature; in the genus *Slavina* there are a series of these 'Sinneshügel,' as VEJDOVSKY has called them, on each segment, the actual arrangement differing with the species; these elevations consist of specially elongated cells which terminate in fine processes projecting beyond the cuticle. In *Lumbriculus* the same author has figured 'Becherförmige Organe,' which appear to be very similar; they are hemispherical elevations of the skin due to the elongation of groups of epidermic cells, which terminate in the same way in fine processes. In *Rhynchelmis* there are developed, at the breeding season, continuous zones of sense-cells arranged in groups; the cells have the same elongated form that the sense-cells generally show, and appear also to possess the fine processes already mentioned; VEJDOVSKY believed that he could trace nerves into connexion with these cells.

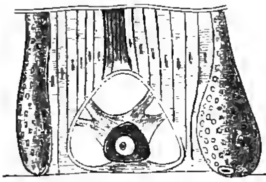
VEJDOVSKY and CERFONTAINE have described and figured groups of what appear to be sense-cells in *Lumbricus;* these consist of long cells which are so arranged as to project slightly from the general body-surface; they are furnished at the extremity with fine processes and occur chiefly on the anterior part of the body, often in particular proximity to the setae. Among the exotic earthworms but little is known of sense-organs; MICHAELSEN has figured and described in *Acanthodrilus georgianus* a pair of papillae on the tenth segment which would seem to be sense-organs rather than glandular modifications of the epidermis; they consist of the same kind of elongated cell that is usually associated with sense-organs; and fine strands, apparently of a nervous nature, could be traced into them; it is very possible that similar papillae, many of which, indeed most, have not been subjected to microscopic examination in other Acanthodrilides and other earthworms, are sensory in function.

Eyes are present in a few Naids. They appear to consist of a lens-like body embedded in a cup of pigment; a strong nerve from the brain supplies each eye.

In the genus *Pontoscolex* and also in the nearly allied *Onychochaeta* there are certain peculiar epidermal structures which may be of a sensory nature; these were first described by PERRIER and have since been described and illustrated by HORST and by myself in the same genus. They consist of a large spherical deeply staining cell imbedded in a large sac which lies at the base of the epidermis; the cell has a conspicuous nucleus, as is shown in the figures of both PERRIER and HORST. The

sac in which the cell in question lies seems to be connected with the surface by a canal; such a canal is figured by PERRIER, but HORST does not indicate it distinctly. VEJDOVSKY compared these cells with the large cells in *Anachaeta*, which represent the missing setae; I supported that contention because it appeared to fit in with my view that the 'Perichaetous' condition is the more primitive, and that these cells were the remains of a Perichaetous condition in *Pontoscolex;* I am not now convinced of the justice of this view—which is not shared by HORST; it seems probable, as he suggests, that the cells are of a sensory nature; as to the special sense of which they are the organs that is a matter impossible at present to decide; it is just conceivable that they may be rudimentary eyes; the central cell appears to be highly refractive and a ray of light would pass through it to the tissue below; but the entire absence of any pigment layer in connexion with the organs seems to negative the likelihood of that view. In the meantime, the accompanying woodcut expresses the general form of these organs which may be regarded as sense-organs of some kind. I did, but do not, compare them to the 'Pacinian bodies' of *Eudrilus*, etc.

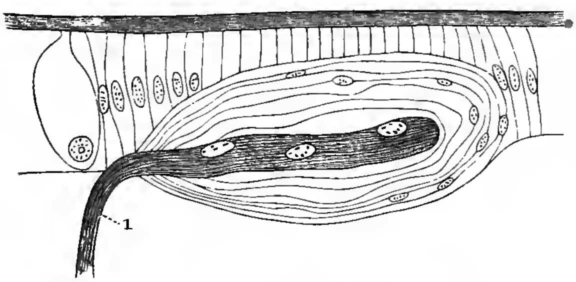
Fig. 3.



EPIDERMAL SENSE CELL OF PONTOSCOLEX.
(After Horst.)
The cell is in the middle of the figure.

A peculiar form of sense-organ is to be met with in many Eudrilids. These organs were first described by myself in *Eudrilus* (**62**) and compared, erroneously as I now think, with the epidermal bodies of *Pontoscolex* that have just been described. Since then they have been studied by HORST in *Eudrilus* and by myself in several other genera, such as *Hyperiodrilus* and *Heliodrilus*. They are somewhat oval bodies, and lie just below the epidermis, though above the circular muscles; the cells of the epidermis which cover them are shorter than the others and not glandular. These bodies consist (see fig. 4) of a deeply staining granular nucleated cylindrical core, round which are apparently wrapped a series of membranes, also nucleated, though with smaller nuclei than the core; the whole structure reminds one most forcibly of a Pacinian corpuscle. In more than one case I fancied that I could detect a nerve fibre passing from the core, and I have represented one in the accompanying woodcut. There is nothing exactly comparable to these organs in any

Fig. 4.



HYPERIODRILUS. EPIDERMAL SENSE BODY.
1. Nerve supplying it.

other family of Oligochaeta; but it does not seem to be too much to assume that they are really sense-organs, though their function must remain a matter of doubt.

§ 7. *Muscular Layers.* In nearly all Oligochaeta the muscular layers of the parietes are arranged in two layers. There is an outer circular and an inner longitudinal. It is a little difficult in so delicate a form as *Aeolosoma* to recognize that both these layers are present. The only exception to this rule seems to be the Enchytraeid genus *Fridericia*, where there are two separate layers of longitudinally running fibres (as well as the circular layer).

In *Lumbricus* (see especially CERFONTAINE), the individual fibres of the circular coat form a layer of some thickness, variable, however, and particularly thin upon the intersegmental regions. The fibres are imbedded in a granular nucleated substance, and have a more or less strongly-marked columnar arrangement. The individual fibres are long and pointed at both extremities—a statement which applies to the muscular fibres of any part of the body—and longitudinally striate. This striation is apparently due to the presence of moniliform fibrils which makes up the substance of the fibre, and which sometimes give it a transversely striate appearance; these fibrils are imbedded in a clear interfibrillar fluid, which is often particularly plain in the axis of the fibre, giving it a hollow appearance.

The 'leech-like character' of the muscular fibres of the earthworm was first pointed out by RATZEL, who, however, believed that only certain parts of the body-wall had muscles of this kind, whereas CERFONTAINE showed that they are general.

The granular stroma in which the fibres are imbedded shows no cell outlines; it contains clear spaces which are probably the 'lymphatic' spaces referred to on p. 30.

The longitudinal muscles of the earthworm form a layer of much greater diameter than the circular layer. In many species, as was first pointed out by CLAPARÈDE (**1**), a peculiar bipinnate arrangement of the fibres exists. The individual fibres appear to be attached on either side of a central rhachis formed by a septum of connective tissue. This peculiar appearance does not exist in all species of Lumbricidae, but it does occur in a few earthworms not belonging to that family. UDE (**3**) explained the appearance not as due to a series of connective tissue septa with fibres regularly given off on both sides, but as due to a series of compartments to the walls of which the fibres are attached all round. CERFONTAINE proved, by histological methods more refined than those open to CLAPARÈDE, that there is really no difference from the circular layer; similar fibres are imbedded in an identical granular stroma; the regularity of their arrangement, however, producing the appearance, wrongly interpreted by CLAPARÈDE, is more marked than in the circular muscles, where, nevertheless, it exists. Here and there, and more particularly

at the insertion of the septa, radial fibres pass along the ground substance and between the longitudinal fibres; these often give rise to the appearance of regular septa.

The aquatic Oligochaeta are, with the exception of *Phreoryctes* and *Pelodrilus*, characterized by the possession of a longitudinal muscular layer consisting of flat flakes or lamellae imbedded in a granular substance. These fibres, or rather plates, show no axial core such as occurs in the Lumbricidae and earthworms generally. In *Fridericia*, as already mentioned, there is in addition to the lamellae and superficial to them, a single row of fibres with an axial core. HESSE has lately shown that in *Fridericia* all these muscles (circular as well as longitudinal) are constructed upon the Nematoid, not Hirudinean, plan. RATZEL had previously stated this of the fibres of the inner longitudinal layer.

The development of the muscles in *Rhynchelmis* has been worked out by VEJDOVSKY. The mesoblastic cells which are to form the longitudinal muscles become spindle-shaped, and the muscular fibre appears within them; the original protoplasm becomes entirely used up or nearly so in the formation of the fibre, while the nucleus atrophies.

In the Lumbricidae (see VEJDOVSKY **9**) there are two or three layers of cells which are converted into the longitudinal muscular layer. The muscular fibres appear first in the deepest cells, i.e. those nearest to the circular muscles; a considerable number of fibres appear in one cell. In the second and third rows of cells the muscular fibres are only developed at the sides; hence the pinnate arrangement in the adult. The cell boundaries are finally lost and the cell-substance remaining over after the formation of the fibres becomes the granular stroma lying between the fibres. The early stage in the development of the longitudinal muscles of *Lumbricus* therefore represents the condition which occurs in *Rhynchelmis*.

The circular muscular layer has been generally put down as also a product of the mesoblast. It seems, however, fairly clear from the observation both of BERGH (**3**) and VEJDOVSKY that epiblastic cells alone are concerned in its formation. On the other hand, in the regenerating tail of *Lumbriculus* (see RANDOLPH **4**) it is stated that the circular muscles like the longitudinal are a product of the mesoblast.

II. THE NERVOUS SYSTEM.

The nervous system of the Oligochaeta is formed upon the same plan as that of the higher Chaetopoda; the cerebral ganglia communicate with a ventral ganglionated chain by a circumoesophageal commissure—the entire cord lying in the body-cavity.

In only one case is the primitive connexion of the cerebral nervous system with the epidermis retained. This occurs in *Aeolosoma*; in all the species of that genus which have been microscopically examined, the cerebral ganglia, though projecting into

the body-cavity, are in connexion with the epidermis. In this worm — and it is quite unique among the Oligochaeta—the entire central nervous system is confined to the cerebral ganglia ; the ventral nerve cord appears to be entirely absent, except in *Aeolosoma tenebrarum*, where it exists in a rudimentary form in the shape of a few scattered cells.

In all other Oligochaeta there are not only the cerebral ganglia connected by the circumoesphageal commissures with the ventral chain, but there is in addition a system of small ganglia arising from the cerebral ganglia, and concerned with the nerve-supply of the anterior section of the alimentary canal; in some forms also there is a 'lateral line system.' These various parts of the central nervous system may now be considered in detail.

Cerebral Ganglia. These lie further forward in the lower than in the higher Oligochaeta; in the Tubificidae and the lower forms generally they are situated in the first segment; in the earthworms, almost without exception, they have moved back to the third segment; but the development shows that the former is the primitive position; they are moved back in the earthworms by the invagination of the stomodaeum. In most, if not all, earthworms the cerebral ganglia mark the junction of the buccal cavity and the pharynx. Why it should be so is mysterious, but it is a fact that in the more highly organised Oligochaeta the brain is smaller and simpler than in the lower forms. In the latter—in the Tubificidae and Naidomorpha for example—the brain is not only relatively large, but it is provided with accessory lateral lobes, and is often prolonged posteriorly into posterior lobes. The form of the brain in these worms is often highly characteristic of the genus or species. Some references to the particular form of the brain will be found in the systematic part of this work. In *Phreoryctes* the brain has the simple bilobed character that is characteristic of the higher Oligochaeta to which this worm is related. The Lumbriculidae also have a simple brain. Among the Tubificidae there is often an impaired anterior median prolongation of the brain, which sometimes comes to be detached and remains in connexion with the brain by a nerve-cord. The formation of this anterior ganglion is highly suggestive of the buccal ganglia in the Mollusca. Special muscles are often attached to the brain in the lower Oligochaeta, which are apt to be confounded with nerves derived from it[1]. The cerebral ganglia give off a number of peripherally running nerves.

The simplest arrangement of these again is found in the higher Oligochaeta—a fact which must, as it appears to me, be taken into consideration in fixing their position with respect to the so-called 'lower' forms. Vejdovsky only finds one pair in the genera *Lumbricus* and *Criodrilus*; Rosa figures an identical disposition for *Hormogaster*, and

[1] They are attached of course to the connective tissue-sheath.

PERRIER for *Pontodrilus*; on the other hand, according to the last named author, *Pontoscolex* has two pairs of nerves arising separately from the brain, a pair of course on each side. SPENCER figures only one pair of nerves in *Megascolides australis*, which arise, as usual, near to the circumoesophageal commissures. Thus it appears general among the higher Oligochaeta for there to be only a single pair of cerebral nerves, which may however, and usually do, divide at once into two. I shall point out later, in describing the peripheral nerves given off from the ventral cord, the fact that there are there three pairs in each segment; one would suppose that there would be a correspondence between the cerebral ganglia and any one of the ventral ganglia, considering that they are developed as one continuous whole. As a matter of fact this correspondence exists, but it is masked by the origin of the third pair of nerves from the commissure, and not from the cerebral ganglia themselves. There is nothing extraordinary in this, for in the ventral ganglia one of the three pairs of nerves also arises from the commissural part of the cord. There is thus really a correspondence between the 'cerebral' and the 'spinal' nerves. How for does this hold good in other groups? The most careful figures known to me of the nervous systems of the lower Oligochaeta are those of VEJDOVSKY and of STOLC of the Tubificidae. In *Ilyodrilus* the latter figures three pairs of cerebral nerves, and also three pairs in each segment arising from the ventral cord. In *Spirosperma* there are four pairs of nerves springing from the cerebral ganglia, and also four pairs from the nerve-cord in each segment (?), one being commissural. In *Monopylephorus*, however, there does not, it must be admitted, appear to be the least correspondence.

The cerebral ganglia are united with the ventral chains by the commissures which embrace the gullet; from the commissures arise the visceral ganglia.

Visceral Nervous System. This appears to occur in most, if not in all, Oligochaeta. In the earthworms it has been figured and described in *Pontodrilus*, *Pontoscolex*, *Megascolides*, *Hormogaster*, &c. I have never found it to be wanting in any earthworm where I have looked for it. It consists of either a solid mass given off from the commissure or of a plexus having a similar origin; the plexus, however, is not entirely formed of nerve-fibres; there are also ganglionic cells; these branches of the visceral system ramify in the coats of the buccal cavity and pharynx. Among the lower Oligochaeta the same visceral nerves are met with; thus VEJDOVSKY figures in *Chaetogaster* a pair of ganglia on either side of pharynx, which are connected with the brain. Other groups have the homologous ganglia, and reference must be made to VEJDOVSKY's work for further details.

Nerves of lateral line. In many Oligochaeta—and its occurrence is probably general—there is a nerve on either side of the body arising from the brain or from

the oesophageal commissure, which has been compared to the nerve of the lateral line in fishes; it appears to consist especially of nerve-cells. This system of nerves has been described by VEJDOVSKY as existing in the Enchytraeidae, Phreoryctidae, Naidomorpha, Tubificidae, and Lumbriculidae[1]. Connected with it is a system of fine fibres which supply the walls of the alimentary canal; in *Chaetogaster* the oesophagus has a ring of nerve-cells round it, which are apparently referable to this system of intestinal nerves, which may fairly be compared with the Sympathetic system of Vertebrates. This nervous supply of the alimentary canal will not of course be confounded with the visceral nerves already described as arising from the circumoesophageal commissure. The lateral nerve itself or rather ganglionic chain originates from the epidermis, and remains in connexion with the same, the longitudinal muscles being separated where it occurs.

Ventral Nerve-Chain. The commissures which arise from the brain and embrace the gut unite below it to form a ganglionated chain. This runs from end to end of the body; in the extreme posterior region, where a regeneration of segments is going on, the ventral nerve-cord may be often seen to lie in the thickness of the epidermis; otherwise it always lies in the body-cavity; but VEJDOVSKY states that it is for the most part naked; that is, not covered by a continuous coating of peritoneum; scattered cells of the peritoneum are attached to it here and there. The nerve cord is usually enclosed in a muscular sheath, which may be, or is sometimes not, continuous right round it; but this nerve-sheath is derived from the same embryonic cells as those which form the cord itself. The cord may be divided into the ganglionic and the non-ganglionic or 'connective' part; the degree to which these are differentiated varies; in *Chaetogaster* for instance, they are sharply marked off from each other in the figures given by VEJDOVSKY; on the other hand it is the rule among earthworms for there to be only a slightly marked distinction; SPENCER even went so far as to practically deny, in the case of *Megascolides*, any difference in the whole length of the cord; but VEJDOVSKY found constrictions separating the pairs of ganglia. In any case it seems certain that the ganglionic part of the cord fades gradually into the connective region, and the latter when present is of so short an extent that it is hardly recognisable. It is remarkable that the higher Oligochaeta should in this respect also show more primitive characters than the lower forms.

The primitively double character of the ventral nerve-cord is partly retained for life in the genus *Chaetogaster*. In the Plates illustrating VEJDOVSKY'S work upon the Oligochaeta there are several figures of the nerve-cord of this genus; it will be

[1] HESSE however states that the supposed ganglion cells are only the non-modified protoplasmic portion of the 'nematoid' muscular fibres in Enchytraeidae and Naidomorpha.

seen that in *Chaetogaster cristallinus* the connectives uniting the first, second, third ventral ganglia are most distinctly double, the interspaces left being wide. The same holds good with the species *Chaetogaster diaphanus*; but here the ganglia themselves are distinctly separated, which is not the case with the other species; each ganglion or each half ganglion is connected with its fellow by a short commissure which give to the anterior part of the nerve-cord a ladder-like appearance.

For the remarkable specialisation of the nerve-cord in certain segments of *Phreoryctes* and various Enchytraeidae cf. under the descriptions of those families.

The ventral nerve-cord gives off branches in each segment. These branches arise in two different ways; in the earthworms and in many of the aquatic genera they arise on either side of the nerve-cord and lie in the body-cavity for a greater or shorter distance until they plunge into the thickness of the body-wall. In the Enchytraeidae, on the other hand, in *Phreodrilus*, and in many if not all Lumbriculidae, the two nerves are so closely applied to each other that they appear to be only a single nerve given off from the ventral side of the cord; this apparently single nerve plunges at once into the thickness of the body-wall, and then runs to right and left. This peculiar state of affairs has perhaps led some observers to abstain from figuring or to deny the existence of the branches of the nerve-cord; on a dissection of such worms as show this origin of the branches from the ventral surface of the cord no nerves would be apparent.

In the Enchytraeidae judging from the figures of MICHAELSEN the unpaired character of the ventral nerves is the most marked; in *Rhynchelmis*, on the other hand, the two nerves, although lying close together, are quite distinct as two nerves. They are not present in the middle segment. In the Tubificidae and among earthworms the nerves arising from the ventral nerve-cord do not at once enter the body-wall, but pass to a point at some distance from their origin before they enter the body-wall; the distance varies in different species; as a rule in those species with paired setae the nerves enter the body-wall near to the ventralmost seta; when this is further away from the median ventral line the nerves have a longer course through the body-cavity than when it is nearer to the median ventral line.

The number of nerves given off in a segment varies considerably in different genera of Oligochaeta. In *Lumbriculus* and *Rhynchelmis* VEJDOVSKY could only find a single pair; three pairs is a much more usual number. This occurs for example in apparently all earthworms; it is figured for instance by PERRIER in *Pontodrilus* and *Pontoscolex*.

In these and other earthworms the three pairs are not given off at equal distances from each other; two pairs are quite close at their origin; FRIEDLÄNDER has pointed

out, and I confirm him (for *Perichaeta*), that in *Lumbricus* at any rate the two pairs of nerves which arise close together have a relation to the ventral nerve-cord, similar to that which the dorsal and ventral roots of the spinal nerves have to the spinal cord of most vetebrates; the one in fact is situated more dorsally than the other. This state of affairs is remarkably distinct in certain species of *Perichaeta* which I have examined from this point of view. In *Pontodrilus*—in the segment which contains the spermiducal glands—there is a ganglion on one of these nerves, and just at the ganglion a branch arises which goes to the other nerve; this recalls the ganglion on the dorsal root of the spinal nerves of Vertebrates and the branch which immediately after unites this branch with the ventral root. Although there is this resemblance between all earthworms in the number and position of the branches of the ventral nerve cord in all earthworms, there is by no means a close correspondence between the various genera of aquatic Oligochaeta. Moreover accounts are apt to differ in many cases. For example, in *Tubifex* VEJDOVSKY figures no less than five branches of the cord in each segment; D'UDEKEM gives three as the number, while NASSE only found two.

STOLC figures five branches in *Monopylephorus* and *Lophochaeta*, two being dissepimental branches. I found three in *Phreodrilus*.

There is not much information as to the course of the branches after they have left the nerve-cord; PERRIER carefully dissected out these branches in *Pontoscolex*; he found that one only of the three branched considerably in the thickness of the body-wall. I found in the Perichaetid genus *Diporochaeta* a considerable branching of these trunks within the thickness of the body of the wall, resulting in fact in the formation of a nerve-plexus; on the other hand, I found in the same worm, and I have noticed similar appearances in other worms, that the branches arising from the cord were continuous right round the body, apparently joining dorsally.

The histology of the nervous system is a large subject and one which can only be treated very briefly in the present work. It has been investigated by a large number of observers, including VEJDOVSKY, RETZIUS, FRIEDLÄNDER, etc. In transverse sections of the nerve-cord of *Lumbricus*, three dorsal tubes are very obvious; these have received various names, and very various functions and homologies have been assigned to them. There is now no longer any question that these tubes, the 'Neurochord,' are of nervous nature; for they have been traced into connexion with nerve-cells; there are generally three of them; but occasionally four are present the tubes dividing and reuniting. These tubes in *Rhynchelmis* are developed out of a row of large cells which were formerly (and erroneously) regarded as being of mesodermal origin. The neurochord of the adult is single in the anterior segments and in the brain and the oesophageal commissures. In the middle and hinder part

of the body there are three tubes; these consist of a central nerve-fibre enclosed in a double sheath. The outer sheath has a few scattered nuclei in it and has a fibrous texture; the inner sheath has the same texture but fewer nuclei. The central fibre or rather bundle of fibres is the direct prolongation of certain large nerve-cells. The rest of the nerve-cord is made up of fibres and cells; the latter are ventral and lateral in position. In the brain of course the conditions are reversed. The fibrous part of the nerve-cord consists of a more or less transparent 'cytoplasm,' the remains of a portion of the embryonic cell-mass; this in places forms transverse and longitudinal canals dividing up the meshwork of nerve-fibres into different regions. The fibrous mass is surrounded and the canals of the cytoplasm also, by a delicate sheath the 'Glia sheath'; in this are a few nuclei; it appears to be of the nature of connective tissue and is not connected with the nerve-fibres. The ganglion cells are grouped into a medial and two lateral masses; the cells in *Rhynchelmis* are for the most part unipolar; only seldom are multipolar cells met with; in *Lumbricus* CERFONTAINE figures multipolar and unipolar cells also.

The development of the nervous system has been studied by KLEINENBERG, KOVALEVSKY, WILSON, BERGH, VEJDOVSKY, etc. WILSON discovered, and the subsequent observers confirmed him, that the cells which form the nervous system, like those which will form the nephridia, originate from a single cell on each side, placed near the posterior end of the body and termed a 'teloblast'; continuous with this teloblast and forming a row of cells produced out of it is the layer which will ultimately become the nervous system; the teloblast is an epiblastic cell and there is therefore no doubt as to the epiblastic character of the central nervous system in the Oligochaeta. It appears to be entirely formed by the proliferation of these cells, and WILSON declares that the cerebral ganglia are formed continuously with the ventral chain; it follows from the mode of origin just referred to that the ventral cord and the cerebral ganglia are a double formation, that the nervous system is bilaterally symmetrical; it has been held that it is a single formation laid down in one band. BERGH, while confirming WILSON, made the interesting addition to his facts that in the embryo there is a series of branched cells evidently of a nervous nature, which lie between the two nervous rows; BERGH thought, and VEJDOVSKY confirmed him, that this plexus of cells and fibres is to be traced to the ventral epiblast and has no relation to the neuroblasts already referred to. Whether these cells have any relation to the definitive nervous system seems to be at present a matter of some doubt. VEJDOVSKY looks upon this primitive plexus as a remnant of the nerve-ring of the *Medusa*. The histological differentiation is so special a matter that I do not enter into it here. For details the reader is referred to VEJDOVSKY'S work (**9**).

III. Coelom.

The coelom in the Oligochaeta is invariably spacious and nearly invariably divided into compartments which correspond with the external metamerism. The division is effected by means of the intersegmental septa which are only wanting in *Aeolosoma*; these septa are not as a rule applied to the parietes in such a way as to exactly correspond with the grooves on the exterior of the body that mark the segments; hence the internal metamerism is not precisely as the external metamerism. The coelom is lined throughout by the peritoneal epithelium, which is reflected over all the organs that lie within it; from its wall are developed the gonads; it communicates with the exterior directly by means of the dorsal pores, and indirectly by means of the nephridia and the genital ducts.

The coelom of the Oligochaeta is developed out of the paired mesoblastic masses which are formed early in the embryo; each pair joins its fellow in the mid-dorsal and mid-ventral line; but there is a nearly complete fusion above and below. No longitudinal septum remains to mark the division of each compartment of the coelom into right and left halves, and on the ventral side there is the mesentery supporting the ventral vessel only, which represents the ventral part of the line dividing the right and left halves. It has been stated that in *Criodrilus* the dorsal septum is persistent, but this appears to be an error. As a general rule, the coelom shows no signs of division into different cavities, except of course by the intersegmental septa; but this rule has a few exceptions. In the first place, the sperm-sacs and egg-sacs are undoubtedly portions of the coelom enclosed by special walls, which are set apart for the maturation of the sperm and ova respectively; these structures are dealt with under the description of the reproductive organs. In addition to these there are the remarkable sacs which envelop the gonads and the spermathecae in many Eudrilids, and which form so marked a character of that family. These sacs for the most part play the part of spermathecae, otherwise for the most part wanting in the family Eudrilidae, and they are dealt with under the description of the spermathecae.

The lining membrane of the coelom varies greatly in its characters in different regions of the body; but it is nowhere ciliated, as is the case with other worms (e.g. the Archiannelida). The parietal layer is composed of flattened cells, the nuclei of which can as a rule be alone recognized in transverse sections; this epithelium can be demonstrated by the silver method with great success (see Power). Claparède too has figured the flattened coelomic epithelium upon the nerve cord, though, as already mentioned, Vejdovsky has stated the non-continuity of the coelomic

cells upon the nervous system. The layer of peritoneum covering the alimentary canal is greatly modified, particularly upon the intestinal region. To this layer the name of 'Chloragogen-cells' was applied by CLAPARÈDE. The layer was at one time thought to be a digestive gland; and the fact that the cells end in a finish thread which is closely applied to the wall of the intestine favoured the supposition. It was pointed out however by CLAPARÈDE that these cells are not so much connected with the intestine as with the blood-vessels upon its surface. According to KÜKENTHAL their function is that of extracting waste substances from the blood and setting them free into the body-cavity whence they are removed by the nephridia. These chloragogen-cells contain greenish to blackish granules, the pigmentation being more marked in some species than in others. Upon the nephridia the coelomic epithelium often shows a different modification; the nephridia are of course always enveloped in a layer of this tissue as are all the organs lying in the coelom (except the gonads, which *are* peritoneum); but it is frequently a thin and barely discernable layer; this is not the case with the aquatic Oligochaeta; but those worms which appear to have the densest peritoneal layer round the nephridia are the Eudrilidae. The cells are often loaded with round granules of various sizes; the presence of these gives the nephridia, when viewed with the naked eye, a very conspicuous and white appearance. The coelomic cells which line the spermathecal pouches in the Eudrilidae are also very large; they are pear-shaped and are often apparently in a condition of rapid proliferation. It is quite otherwise with the cells lining the sperm-sacs and the ovisacs; in these sacs the peritoneal layer is but little conspicuous. The peritoneum, if it be really so, which lines the large spermathecal sac of *Polytoreutus*, has quite the appearance of a columnar epithelium. There is a further peculiar modification of the coelomic epithelium enveloping the remarkable calciferous glands of many Eudrilidae for which see the description of those glands.

The coelomic cavity of the Oligochaeta also contains free corpuscles. In the higher Oligochaeta these are apparently of two kinds; there are small amoeboid corpuscles and large spherical corpuscles loaded with granules; in addition to the corpuscles there is also a certain amount of fluid which is coagulated by alcohol. The two kinds of corpuscles referred to are probably merely stages in growth; when the cell becomes loaded with excretory (?) products it naturally loses its activity of movement and assumes the spherical form referred to. Very remarkable are the elliptical corpuscles of the Enchytraeidae; these have a fixed outline; sometimes there are round as well as oval corpuscles in the same species.

In the lower Oligochaeta the corpuscles are often extremely abundant; this is particularly the case with the Enchytraeidae and the Naidomorpha; in the latter

worms one would be disposed to put down the immense numbers of free corpuscles to the process of asexual reproduction with which their presence seems to be connected. But this will obviously not do for the Enchytraeidae, where there is of course no asexual reproduction[1]. Among earthworms there is generally not such a great abundance of corpuscles; but in many Eudrilids there is—a circumstance which gives to these species in many cases a milky white appearance (e.g. *Megachaeta alba*). In the embryos of *Octochaetus* I noticed a very large quantity of corpuscles, the presence of which may be related to rapid growth and excretion. There are in most, if not all, Oligochaeta apparently the equivalents of phagocytes; these were first noticed by HOFFMEISTER. Generally in the posterior region of the body are to be seen masses of brownish cells enclosing old and broken setae; the latter are evidently in the process of removal by disintegration; possibly this goes on until they can be thrown out of the body by the dorsal pores or the nephridia.

§ 1. *Perihaemal spaces.* Besides these chambers, formed by a sub-division of the coelom, there exist others which for the most part involve various portions of the vascular system. The first structure of the kind to be described occurs in the Acanthodrilid *Deinodrilus*; in this worm the dorsal vessel is seen on a dissection to present an obscured appearance, which is due to the fact that it is enclosed in a sac which completely surrounds it and separates it from the general body-cavity. In this worm the dorsal vessel is completely double, and corresponding to this is a separation between the two halves of the 'pericardium.' In transverse sections, through the dorsal vessel, the sac in which each of the two trunks lies, is seen to consist of a very delicate muscular layer, which is covered externally and lined internally by a cellular coat; the external covering is formed of few and delicate cells; on the other hand, the internal lining consists of large cells, which are here and there heaped up into piles. At intervals delicate strands of muscular fibres pass from the walls of the sac to the contained blood-vessel, where they pass between the large chloragogen-cells which cover the blood-vessel and become lost in its muscular layer. This perihaemal space seems to commence a little way behind the head of the worm, but I have not fixed the actual point at which it commences, nor its connexion, if any, with the general coelomic space.

SPENCER (1) subsequently recorded the presence in *Megascolides* of a similar sac enveloping the dorsal vessel; in this case, however, there is a further complication. It possesses in fact a series of diverticula, one more dorsal, the other more ventral in position; these diverticula—the dorsal ones especially as figured by SPENCER, are crammed with free and slightly attached cells; the main tube enveloping the

[1] Cf. however LEMOINE (2), by whom simple division is stated to occur.

dorsal vessel does not extend throughout the body; it is connected with the general coelomic cavity by a ventrally placed slit situated anteriorly, just where it narrows to pass through the intersegmental septum.

The dorsal vessel is not the only vessel which is enclosed in a special perihaemal space; in the Eudrilid *Libyodrilus*, the two sub-intestinal vessels are enclosed in a space of the same kind; two mesenteries arise from the ventral wall of the oesophagus, which meet below and shut off a space with a crescentic outline; in this space run the two vessels in question. For a part of their course the vessels are free in the interior of the space, further back they are attached to the walls of the space, and further back still they come to lie outside of them. The spaces in fact are each of them confined to a segment, and do not pass continuously from segment to segment.

In the two closely allied genera *Heliodrilus* and *Hyperiodrilus*, the supra-intestinal vessel is in the same way enclosed in a coelomic space, distinct from the general coelomic cavity. As in the case of the dorsal vessel of *Deinodrilus*, the walls of the perihaemal space are connected here and there with the walls of the contained blood-vessel by delicate strands of fibrous tissue. The interspaces of these are filled with corpuscles. It seems possible that the function of these perihaemal spaces is concerned with the formation of the coelomic corpuscles; they were always found to be filled with corpuscles, and in more than one instance the corpuscles could be observed in the act of being budded off from the walls of the space.

§ 2. *Other subdivisions of Coelom.* A subdivision of the coelom only paralleled in the Polychaeta occurs in the genus *Libyodrilus* and in the aquatic *Branchiura*. In the former worm the two pairs of seta of each side of the body arise from the floor of a chamber which is cut off from the general coelomic cavity. There are thus a pair of chambers along the body like the parapodial chambers in certain Polychaeta. The membrane which forms the wall of these chambers is thin and presents no appearance of structure except externally, where it is covered by nuclei; the nuclei are on both sides; the membrane is continuous with the parietal peritoneum; the band of muscles uniting the two pairs of seta lies well below the membrane, which in section is seen to be somewhat, though not greatly, arched. Something of a similar kind occurs in the Tubificid *Branchiura*. Here the body at least in the posterior region is hourglass-shaped in transverse section; from the 'waist' of the hourglass a septum runs across the body-cavity transversely, dividing it into an upper chamber which contains the gut, and a lower chamber in which lie the nervous system and both dorsal and ventral blood-trunks.

In addition to the coelomic tubes which have been described as surrounding some of the blood-vessels in certain Oligochaeta there is in *Allolobophora* a ventral tube

which VEJDOVSKY, who discovered it, compared to a lymphatic trunk; it runs on the ventral surface of the body between the intestine and the nerve-cord, and is of limited extent.

All these tubular cavities are suggestive of lymphatic vessels. In the thickness of the body-wall there are often irregular spaces and clefts which are filled with corpuscles. Attention was first directed to these by KÜKENTHAL (1) who saw in them a foreshadowing of the Vertebrate lymphatic system. They occur apparently in a good many different genera, but in none have they proper walls of their own; they are merely clefts and crannies left between the muscles.

The branchiae of the genus *Branchiura* are hollow structures containing what I presume to be an extension of the coelom. This cavity however is traversed by anastomising fibres with nuclei at the nodal points; whether it is lined by a definite coelomic epithelium or not I am uncertain; the cavity is however shut off from that of the coelom by a muscular diaphragm which during life is in constant movement. It seems to be quite imperforate—to completely separate the coelomic and intrabranchial cavities. Very frequently this diaphragm was convex towards the body-cavity. If it were pulled out so as to form an ampulla lying in the body-cavity there would be a state of affairs comparable to that which is met with in the cephalic tentacles of *Saccocirrus* where MARION and BOBRETZSKY have described a cavity communicating with an ampulla lying in the body and have compared to the ampullae of Holothurians.

§ 3. *Coelomic organs of problematic nature.* Attached to the anterior septum of segments x. and xi. in *Sutroa* are two bodies suggestive at first sight of sperm-sacs. These are of a racemose form and are hollow; the cavity is however not single, but divided up by trabeculae into numerous subsidiary cavities. The walls are thin and apparently muscular. Enclosed within the meshes are many loosely packed cells. EISEN first called attention to these bodies, but compared them to the albumen glands of *Rhynchelmis.* I could myself find no duct; and the fact that in one case a diverticulum of the spermatheca lay within the sac led me to regard the cavity of the sac as coelomic.

In certain Perichaetidae there are a series of minute paired whitish bodies lying one on either side of the dorsal vessel in the middle region of the body, and springing from the septa (in *Perichaeta indica*) or from the dorsal vessel itself (*Perichaeta dyeri*). These bodies are quite solid, consisting of a mass of cells surrounding a few muscular fibres.

In *Acanthodrilus falklandicus* there are a series of similar bodies commencing at about segment xx. and continuing to the end of the body. They are attached to the septa near

to the nephridia and are not solid but hollow outgrowths of the septa; they are often rather racemose in form and are chiefly muscular with a lining and covering of cells. The opening of their lumen into the cavity of the segment in front of that which contains them is visible. CLAPARÈDE has described and figured in the common earthworm solid masses of cells enclosing a few muscular fibres and depending from the septa. VEJDOVSKY states that similar bodies occur in *Rhynchelmis* and *Tubifex*. He suggests that they are concerned with the growth of the septa. I found that the septal sacs of *Acanthodrilus* were rich in Glycogen. The structure of the septal sacs in this worm and in *Sutroa* is so like that of the sperm-sacs and egg-sacs that it is possible to see in them the remains of a segmentally arranged series of sacs out of which the sperm-sacs and egg-sacs were originally evolved.

§ 4. *Dorsal Pores.* The coelom is placed in communication with the external medium in a large number of Oligochaeta by a series of pores, one to each segment; in addition to these structures which are called the dorsal pores there is in a certain number, most of the aquatic Oligochaeta, a single pore on the prostomium which is generally spoken of as the head pore. The two coincide in the same species in the genus *Fridericia* alone. The dorsal pores are never developed upon the first one or two segments of the body, and the point where they commence is characteristic for the species; in some forms for example the first one will lie between segments iv. and v., while in others the first pore lies altogether behind the clitellum. The dorsal pores were considered at one time to lead into sacs, the function of which was believed to be respiratory; it is now known that the pores are simply perforations of the integumental layers just at the anterior boundary of the segment to which they belong; there is no lining of epithelium as has been erroneously stated to be the case; there is simply a discontinuity of the muscular and epidermic layers where the pores exist. The structure of these pores has been more particularly studied by UDE (**3**). In the figure which this author gives of a section through a dorsal pore there are represented a heaped up mass of peritoneal cells in the immediate neighbourhood of the pore; the function of this is very doubtful. Dorsal pores are not present in by any means all earthworms; they are absent for example in most of the Geoscolicidae, in many if not in all Eudrilidae, and in a few species of Acanthodrilidae and of other families; among the lower Oligochaeta they are only found in a few species of *Fridericia* (Enchytraeidae). Their structure in the latter has been studied by VEJDOVSKY and MICHAELSEN; in these worms the pore is bordered by large round glandular cells on each side; no such cells are visible in the case of the dorsal pores of earthworms. We are at present completely in the dark as to the morphological meaning of these pores. There seems to be no relation between them and any other organs; pores

opening into the body-cavity from the exterior undoubtedly suggest nephridial organs; but no relations are apparent between the dorsal pores and the nephridia.

The head pore is present in the Enchytraeidae, Naidomorpha and Lumbriculidae; its position differs: sometimes it is at the very tip of the prostomium, sometimes at the junction of the prostomium with the buccal segment. A head pore has not been described in any earthworm. As to the function of these pores MICHAELSEN thinks that the head pore acts as a kind of safety valve to prevent undue pressure upon the brain when the movements of the body force an unusual amount of coelomic fluid into the anterior end of the worm's body. The dorsal pores he thinks have the function of moistening the body and preventing its becoming unduly dry; it is certain that the coelomic fluid is pressed out through the pores; and their occlusion is regulated by longitudinal muscles which pass from the margin of one pore to that of the pore lying behind. SPENCER even thinks that it is used for the purpose of rendering the burrow of the worm sufficiently damp for it to move with comfort in; possibly some coelomic fluid is forced into the cocoon by the movements of the body when this is passed over the head. This latter function seems to be a likely one; the use of the coelomic fluid as a lubricant seems to be, so to speak, too expensive, especially when there are glands in the skin which appear to serve the same purpose. It is not impossible that there may be an analogy between the dorsal pores and the nephridia on the one hand, and the vertebrate kidney on the other. In the kidney there seems to be a purely filtering action at the extremity of the renal tubules and a secretory activity in the glandular section of the same tubes; perhaps in the Oligochaeta the dorsal pores pass out the waste fluids while the remaining excretory products are elaborated and passed out by the nephridia.

IV. NEPHRIDIA.

The excretory organs of the Oligochaeta, to be treated of in the present section, will be termed 'nephridia' after the convenient name introduced by LANKESTER[1]; the older name of 'segmental' organs—used by WILLIAMS, though it survives in many text books, is not so useful, since it tends to disguise the real nature of the organs in question; moreover the term 'segmental' suggests that they are always metameric in arrangement, which is not invariably the case; and that they are present in every segment of the body, which is also as far from being the truth.

§ 1. *Excretory organs in the embryo.* Recent researches on the development of the Oligochaeta, particularly those of VEJDOVSKY (**9**), have shown that at various

[1] Notes on Embryology and Classification, Q. J. Micr. Sci. 1875.

periods in the life-history of these worms there are four sets of excretory organs; the very young embryo is furnished with certain epiblastic cells probably of an excretory function; the older embryo has a pair of larval pronephridia; the older embryo a set of embryonal pronephridia, and finally there are the definitive nephridia of the adult; the terms used are those introduced by VEJDOVSKY in his work already quoted (**9**). These various excretory organs will now be considered seriatim.

(*a*) *Excretory cells.* In the gastrula stage of various species of *Lumbricus* and *Allolobophora* there are a few large cells which are thus early set apart to perform an excretory function; so at least it is believed from the fact that they contain canals in their interior which are often coiled in quite a complicated fashion. They are epiblast cells distinguished by their large size and more granular appearance; they always mark the anterior end of the embryo and only persist during the younger stages; they do not exist in *Allolobophora foetida*, nor were they found in *Rhynchelmis*. There are three of these cells. But they get to be completely fused so that no cell-outlines, but only the three nuclei, are distinguishable. The canal appears to become lost in the primitive body-cavity, lying between the epiblast and hypoblast. When the cells are kept under observation the liquid contained in the canals is seen to be evacuated; after this has taken place the canals are no longer visible, but the cell-boundaries come into view; for further details the reader must refer to VEJDOVSKY's work (p. 208 et seq.).

(*b*) *Larval pronephridia.* These were first seen by VEJDOVSKY in *Allolobophora* at a stage when the blastopore was still large: it is a fine canal running in the primary body-cavity. There are ultimately a pair of these tubes; these tubes do not exist in *Rhynchelmis* nor in *Allolobophora foetida*, but they are as described by BERGH (**4**) enormous in *Criodrilus*. The tubes are ciliated and open on to the exterior anteriorly; in *Lumbricus rubellus* alone did VEJDOVSKY find an internal 'flame-cell.' The organ opens on to the exterior through the lumen of the excretory cells; under the description of these the extension of that lumen into the primary body-cavity was mentioned. These tubes persist during the first formation of the embryonal pronephridia.

(*c*) *The embryonal pronephridia* have no relation at all to the last, but they give rise to the permanent nephridia. These occur in every segment of the body, and the first pair open on to the exterior by the headpore of the embryo *Lumbricus*; this first pair commonly occupy two segments and their lumen is not always ciliated. They are developed before the others, and disappear early, in a number of forms such as *Lumbricus* and the aquatic Oligochaeta. The name 'headkidney' has often been applied to this first pair, and they have been supposed to be different from the pairs which follow them. The principal difficulty in comparing them is the fact that the external pore is differently placed, being dorsal instead of ventral, and that they occupy

two or three segments. The latter fact is explained by VEJDOVSKY as due to the late appearance of the septum, which thus allows the nephridium to grow backwards. As to the first point, the apertures in question, though dorsal in *Lumbricus*, are ventral in *Rhynchelmis*. There can be no doubt of the homology of the first pair of embryonal pronephridia in the two forms, and so the different position becomes a matter of subordinate interest. Although the pronephridia of the first segment disappear in *Lumbricus*, this is not universally the case; I found that in *Octochaetus multiporus* the first pair of nephridia persisted and fusing with the next pair became the 'peptonephridia' opening into the buccal cavity (see p. 46). The persistence of these nephridia in *Octochaetus* is of course an additional argument in favour of regarding the first pair of these organs in *Lumbricus* and *Rhynchelmis* as equivalent to the pairs which follow and are converted into permanent nephridia.

The following pairs of pronephridia in both *Rhynchelmis* and *Lumbricus* are short straight rows of cells without a lumen, but ending anteriorly in the case of *Rhynchelmis*, but not of *Lumbricus*, in a 'flame-cell' provided with a long flagellum pointing backwards along the inside of the organ. These nephridia exist in the anterior segments of the body from which in the adult *Rhynchelmis* they subsequently disappear. In the Lumbricidae the pronephridia arise from a continuous string of cells (not proved in *Rhynchelmis*); this was first discovered by WILSON, it having been previously found by WHITMAN to hold good for the leech *Clepsine*. WILSON'S results are so far confirmed by VEJDOVSKY (**9**). This string originates from a single large cell, the nephridioblast; the row of cells is called by VEJDOVSKY the 'nephridiostich'; traced forward this row is seen to break up into oblique rows of cells each surmounted by a larger one which is on the ventral side of the body. The large terminal cell of each is the cell from which the funnel will ultimately be formed; but it never shows the vacuole with the contained flagellum which is to be seen in the corresponding stage of *Rhynchelmis*.

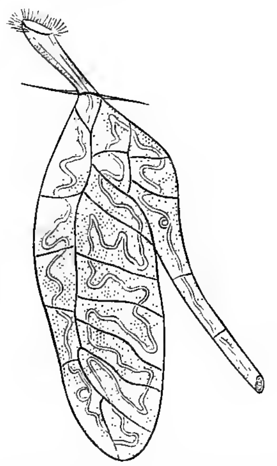
From these pronephridia the permanent nephridia are developed; but before describing the way in which this development takes place it will be convenient to cast a glance over the general anatomy of the permanent nephridia in the Oligochaeta.

§ 2. *Nephridia of adult.*

Nephridia exist in all Oligochaeta. The only exception which there are good grounds to believe is really an exception in the Naid *Uncinais littoralis;* BOURNE, who carefully studied this species (**5**), was unable, after repeated observation, to discover any trace of nephridia. Another peculiar condition of the nephridia has also been described by BENHAM, and noticed by others, in certain Naids; in a few forms the nephridia are

limited to one side of the body; with these exceptions all the aquatic Oligochaeta possess *paired* nephridia a pair to each segment; in all of these families, however, the nephridia are missing from a certain number of segments at the anterior end of the body. This state of affairs, however, is by no means confined to the Microdrili. It is met with in *Pontodrilus*, and the genera *Glyphidrilus*, *Annadrilus*, and *Sparganophilus* among the Geoscolicids; the actual segment in which the nephridia commence is a matter which varies; and as it is rather of classificatory interest, I refer to the description of species for more exact data. In the aquatic Oligochaeta—even if, as in the Lumbriculidae, the nephridia commence before the genital segments,—those segments never contain nephridia; in earthworms, on the other hand, nephridia are present in the genital segments, except in certain of the genital segments in the few species mentioned above as resembling the aquatic families in the want of nephridia in the anterior segments of the body. The nephridia are always much coiled tubes; and they always occupy two segments and two segments only[1]. The internal aperture, the funnel, lies a segment in front of that which bears the external pore. In the lower Oligochaeta the nephridia have no blood supply[2]; they are always covered by a layer of peritoneum, the cells of which are often very large.

Fig. 5.



NEPHRIDIUM OF MARIONIA SPHAGNETORUM.
(After Michaelsen.)

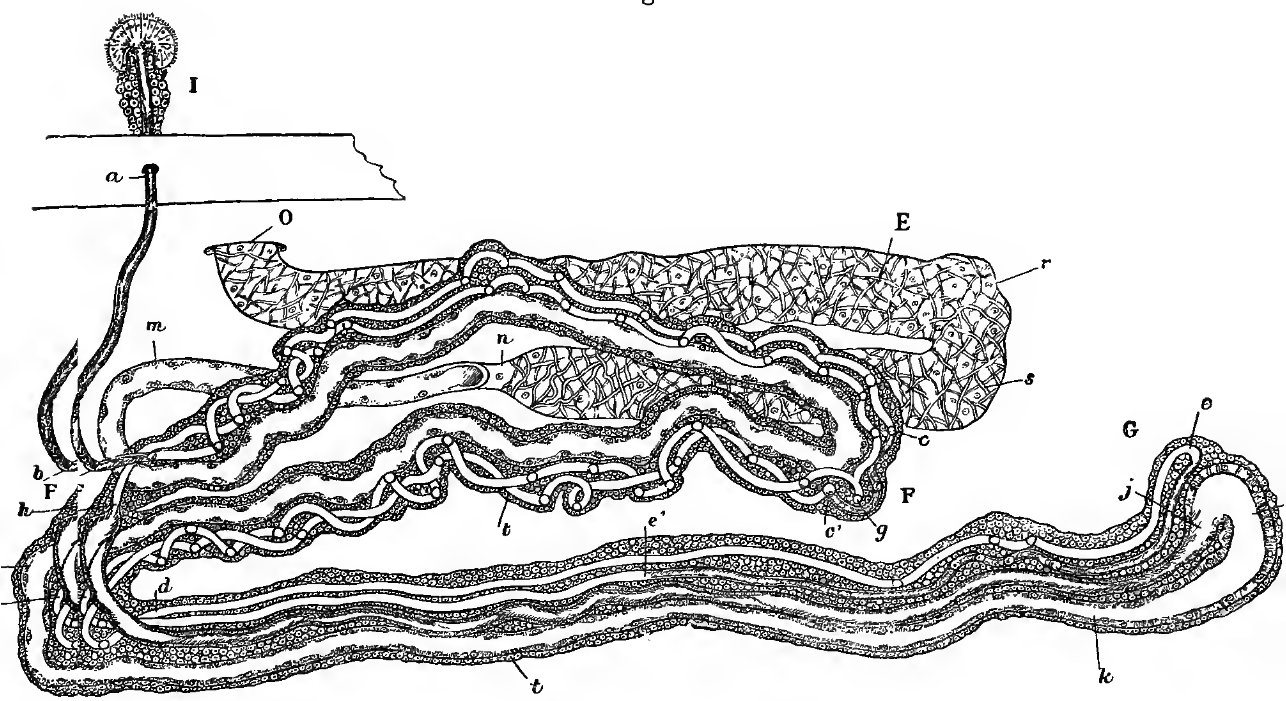
The nephridium of *Psammoryctes barbatus* will be selected as an example of a nephridium in one of the lower Oligochaeta; it is fully described and figured by Vejdovsky (**24**, Pl. ix, fig. 1). The funnel which is composed of but few cells passes into a delicate spirally-wound tube decked with large clear vesicular peritoneal cells; this passes into a thicker walled section of a yellowish colour; this again passes into a clear walled tube which ends in a somewhat voluminous contractile bladder opening on to the exterior. In other aquatic forms the nephridia may be simpler; but the same regions are generally recognisable; not, however, in the Enchytraeidae whose nephridia (fig. 5) are very peculiar and resemble in many particulars the young developing nephridia of the higher Oligochaeta. A solid cellular mass, varying in shape according to the genus, is traversed by a coiled tube, the coiling of which again differs in different forms; from this arises a duct

[1] Doubtfully excepting *Plutellus*. See also remarks on nephridia of *Aeolosoma*.

[2] *Rhynchelmis* is an exception (possibly other Lumbriculidae also); Vejdovsky has figured (**9**, Pl. xxvi, fig. 20) a bloodvessel following the coils of the nephridium.

which passes to the exterior and opens on to it through a small contractile bladder; there appears to be no distinction here between the more or less glandular part of the organ in other Oligochaeta. BOLSIUS has lately discovered that the lumen is really a complex network. Among the Naidomorpha, the Lumbriculidae, and a few Tubificids, the funnel (totally absent in *Amphichaeta* and *Chaetogaster*) is followed by an oval swelling coloured brown, and within which the nephridial tube appears to be branched and to form a small network; VEJDOVSKY describes a network along the

Fig. 6.



NEPHRIDIUM OF LUMBRICUS.

(From Benham.)

a–h the narrow part of the tube partly ciliated. *h–j* ciliated wider tube expanding at C into ampulla. *k–n*. Wide tube. E. Muscular duct. I. Funnel. O. External orifice. *t*. Peritoneal layer. *s*. Muscular fibres. *r*. Nucleus of cell. F. G. 2nd and 3rd loops of nephridium.

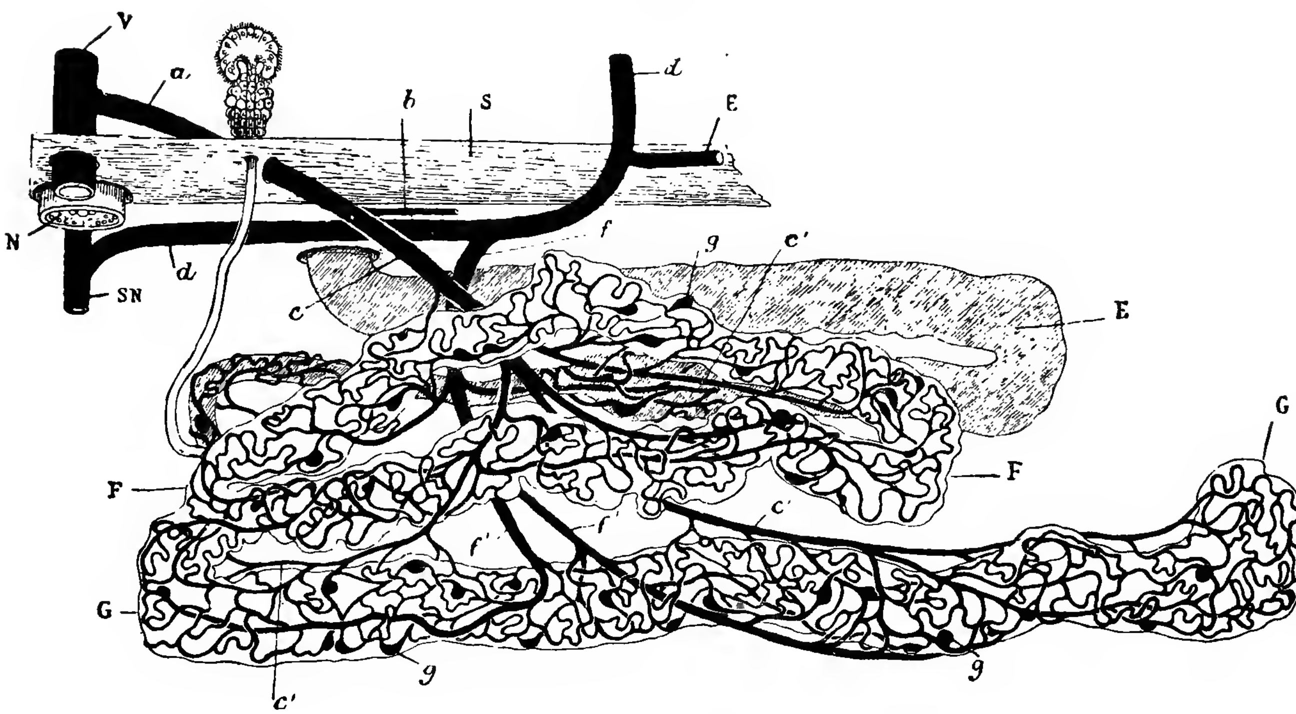
course of the nephridial tubes of *Chaetogaster;* this matter will be referred to again in considering the more complex nephridia of the earthworms.

The nephridium of Lumbricus. The most elaborate description of this organ is due to BENHAM (**9**), whom we shall here follow. The nephridium is divisible first of all into two regions—one lying in the segment in front of that which bears

the external pore, which may be termed the preseptal portion; the other the much more extensive postseptal portion.

The preseptal portion consists of the funnel and of a short tube passing through the septum. The funnel is made up of a considerable number of tall columnar cells, which are ciliated over their entire inner surface; the connexion of the funnel with the tube is effected in the following way: the tube has the usual intracellular

Fig. 7.



NEPHRIDIUM OF LUMBRICUS ILLUSTRATING VASCULAR SUPPLY.

(From Benham.)

E. F. G. 1st, 2nd, and 3rd loops of nephridium. N. Nerve cord. S. Septum. SN. Subnerval bloodvessel. *v.* Ventral bloodvessel. *a. b. c.* Branches of the same. *d.* Commissure uniting dorsal and subnervian vessels. *e. f.* Its branches. *g.* Dilatations on capillaries.

lumen; the two sides of this (in optical section) diverge at about the centre of the funnel, 'each bending outwards, and then sharply backwards nearly parellel to its former course.' The lumen ceases at the point of divergence, the cells being only grooved; the cells are continuous with the marginal cells already referred to. The centre of the horseshoe-shaped funnel has now to be accounted for; this has been

often figured as composed of a mosaic of numerous cells. It is, however, occupied by only a single large crescental cell.

The 'narrow tube' which follows the funnel is the largest part of the whole nephridium; the lumen is wide and of course intracellular [1]; here and there the lumen shows slight indications of branching. Cilia are not universally present, but there is an alternation of ciliated with non-ciliated tract. This is followed by the 'middle tube,' which is of less extent and ciliated throughout; its calibre is greater and the walls are more glandular.

The 'wide tube' commences with a wider dilatation where it communicates with the middle tube. This part is also very glandular, but not ciliated. The last section of the nephridium is formed by the muscular duct. This has apparently a lining of large cells, so that the duct is intercellular; it has numerous muscular fibres in the walls. This part of the tube opens directly on to the exterior. The actual course followed by the windings of the nephridium will be apparent from the illustrations and a special description is unnecessary.

Nephridia of other Genera. Lumbricus is really the only genus of earthworms whose nephridia have been carefully studied from the point of view of their minute structure; there are, however, a few details to hand, which have been for the most part collected together in BENHAM'S paper. In all the earthworms with paired nephridia the same regions of the tube can be distinguished; but frequently there are differences in the relative development of the various parts. This is particularly the case with the terminal muscular section. In many genera of earthworms this section is very wide and large in proportion to the rest of the tube; especially is this the case for example with *Acanthodrilus dissimilis* and a few other species of that genus, and with *Microchaeta,* etc. Moreover, in the species named, the muscular duct of the nephridium has a caecum given off near to its external pore; the presence of such a caecum is very common.

On the other hand, there are a good many species which appear to be without the terminal muscular duct, or in which at any rate it is but slightly developed; this seems to be especially the case with small forms; and it is perhaps a mark of degeneration; such genera as *Gordiodrilus* and its allies show an apparently complete absence of the muscular sac. The above remarks, it will be understood, refer only to the genera with paired nephridia; in those with diffuse nephridia the terminal sac seems to be invariably wanting. The funnel too shows a certain amount of variation; it is larger or smaller as the case may be; in *Rhinodrilus gulielmi*

[1] VEJDOVSKY (9, p. 349, etc.) does not admit intracellular nature of duct; he believes it to be intercellular throughout.

the funnels of the anterior nephridia are very large, and this condition is rather characteristic of the family Geoscolicidae; it occurs also in *Pontoscolex*, where I have described it myself. In the last-mentioned genus the funnel is followed by a very wide section of the 'narrow tube.' The funnel varies in size in different worms, but in no earthworm with paired nephridia is it totally absent.

The occasional branching, or rather the indications of branching, observable in the nephridium of *Lumbricus* have already been referred to; BENHAM has described in *Microchaeta* a complicated branching and anastomosis of the fine tube carried to such an extent that it formed a network round the other regions of the tube; more recently ROSA has met with the same thing in the genus *Desmogaster*; in *Eudrilus* I have seen a certain amount of branching, but not so developed as in the genera mentioned. In all cases the nephridia of the higher Oligochaeta have an abundant blood supply; this runs of course in the peritoneum which invests the nephridia externally; the only genera in which this vascular supply is absent (or, at the most, feebly developed) are *Ocnerodrilus* and *Gordiodrilus*. The actual course of the vessels supplying the nephridium will be described under the vascular system.

Specialization of nephridia. Another matter which is worthy of note in connexion with the paired nephridia is the specialization which is occasionally shown in different regions of the body. Among the Geoscolicidae it is common for a variable number of pairs of nephridia, occupying the anterior segments of the body to differ in structure from those which follow and occupy the rest of the body. The very first pair of all, in *Rhinodrilus ecuadoriensis* for example, but also in worms belonging to other families, often appear to have acquired a different function for they open into the buccal cavity; but the consideration of these is deferred to a subsequent page. I am now concerned with those cases which may be exemplified by *Microchaeta*. In that worm the nephridia down to about the twenty-seventh segment are furnished with a long oval caecal appendage to the terminal sac. In the nephridia from the twenty-eighth segment onwards the terminal sac is larger and wider and is prolonged beyond the external orifice; this prolongation corresponds of course to the caecum in the anterior nephridia, but it is hardly marked and is a continuation of the sac not being bent back upon it.

In *Acanthodrilus novae-zelandiae*, one or two allied species, in *Cryptodrilus fletcheri*, and a few other earthworms, there is a very remarkable specialization of the nephridia, not connected as in *Microchaeta* with the cephalization of the anterior segment. There are in the worms now under consideration two series of nephridia which open on to the exterior either in relation to the ventral or to the dorsal setae; but although there are two series there is only a pair of nephridia in each segment.

I speak of 'two series' because in the *Acanthodrili* at any rate the structure of the nephridium differs in relation to the varying position of its external orifice. When the nephridia open in front of the ventral seta they are provided with a very large caecum; on the other hand, the dorsally opening nephridia have either no caecum at all or the large muscular terminal sac of the nephridium is prolonged a little way beyond the external pore.

Alternation in position of external pores. In addition to the worms just referred to, a curious condition of the nephridia has been described by HUBRECHT in the genera *Lumbricus* and *Allolobophora*[1]; the position of the nephridio-pores shows an alternation similar to that of the worms already described, but there is no change in the position of the nephridia themselves within the body, such as occurs in *Acanthodrilus* for example.

The bare fact of the alternation of these pores has been previously referred to by BORELLI; BORELLI found that in a considerable number of different species this alternation from segment to segment was typical; the following is a list of these species:—

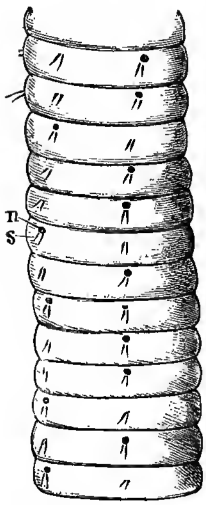
Lumbricus rubellus, Hoffm.
Lumbricus purpureus, Eis.
Lumbricus herculeus, (Sav.).
Allolobophora turgida, Eis.
Allolobophora chlorotica, (Sav.).
Allolobophora transpadana, Rosa.
Allolobophora complanata, (Duges.).
Allolobophora foetida, (Sav.).
Allolobophora celtica, Rosa.
Allurus tetraedrus, (Sav.).

To this list others have since been added—for example ROSA's *Allolobophora tellinii*. In fact it may be taken apparently that the typical arrangement for the genera *Lumbricus* and *Allobophora* is the one that has just been referred to. The position of the pores does not show precisely the same kind of irregularity that has been mentioned in *Acanthodrilus*. BORELLI found, and he has been confirmed by HUBRECHT, that the pores may either occupy the position that is generally assigned to them in the text-books, i.e. just above the second seta, or they may lie in relation to the fourth seta or finally between the fourth seta and the dorsal pore. Moreover there is no regularity in the alternation from segment to segment and not always

[1] I can confirm from my own observations the accuracy of HUBRECHT's statements and figures.

a symmetry of arrangement in the same segment; in the latter facts these genera recall the condition so characteristic of certain species of *Acanthodrilus*.

Fig. 8.



ACANTHODRILUS DISSIMILIS.

s. Setae. *n*. Nephridiopore.

HUBRECHT'S special contribution to this matter is his discovery that when the nephridium opens in an 'abnormal' position the duct enters the body-wall as if it were going to reach the exterior immediately by the ordinary course; instead of which the tube bends to the left or to the right, as the case may be, and passing between the two muscular layers of the body-wall reaches its external orifice. The nephridium itself retains the same position in the body-cavity wherever the external pore may be situated; on a mere dissection it would be impossible to say of any one particular nephridium where the external pore was placed.

The tube as it passes along the body-wall lies so exactly between the circular and the longitudinal layers of muscle that the appearances presented suggest at first sight merely a break in continuity of the body-wall along this line, due to a defect in the section; this may possibly, HUBRECHT thinks, have caused other cases similar to this to have escaped the attention of observers; at any rate there is no doubt that so far as our present knowledge goes a similar state of affairs has not been described in any other genera than those mentioned. These facts have led HUBRECHT to suggest, though very tentatively, another theory of the variations of the nephridia in the Oligochaeta.

It will be remembered that there are certain Cryptodrilids in which three pairs of nephridia are met with. HUBRECHT indicates that the three positions which the nephridiopores occupy in many Lumbricidae may possibly be a reminiscence of the original presence of three pairs just as it has been suggested that the alternation in *Acanthodrilus* may be a trace of the former existence of two pairs of nephridia in the immediate ancestors of this genus. The same arguments that apply in the one case apply in the other.

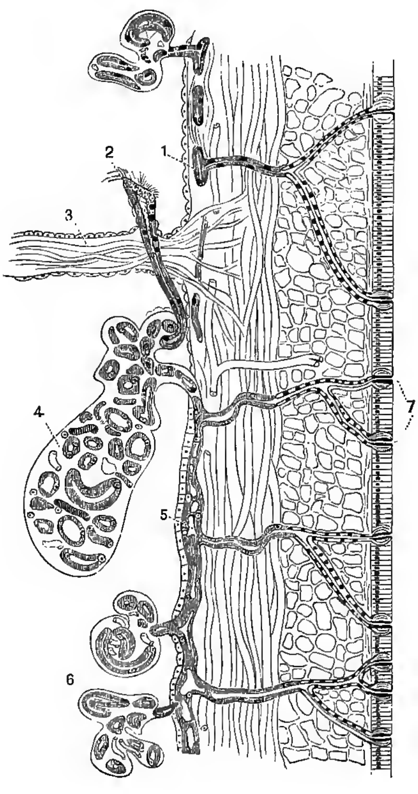
Diffuse nephridia. The nephridia are among those organs of the Oligochaeta which show most variation. For a long time it was thought that they agreed with other segmented worms in possessing a single pair to each segment of the body, a variable number of segments being without nephridia at all. It is now known that this state of affairs is by no means the only way in which the excretory system is developed. A very large number of genera are largely or entirely characterised by possessing

a nephridial system of a different kind. PERRIER first called attention to the peculiar character of the excretory system of *Perichaeta*, which he described in the following words: 'Les organes segmentaires sont ici très rudimentaires, ce qui concorde avec l'absence d'orifice extérieur attribuable à ces organes.' This statement was made of *Perichaeta posthuma;* and later of *Perichaeta robusta* he wrote, 'Les organes segmentaires, sous forme de tubes extrêmement délicate, sont adhérents aux cloisons, ou disséminées sur la membrane péritonéale que tapisse la cavité générale'; further on, in the part of his paper devoted to a general resumé of the anatomy of the group, he speaks of the nephridia forming a 'réseau glandulaire,' which appeared to him to be an indication of an incomplete suppression of these organs.

In a communication addressed to the Royal Society of London (**10**), I pointed out that in *Octochaetus multiporus* there were more than a single pair of nephridiopores to each segment of the body; and that in the interior of the body the nephridia were divided into eight tufts in each segment, corresponding with as many external pores. In a later paper (**47**) I corrected the number, having found a much larger number of orifices. The next statement upon the subject was by BENHAM, who found in a species of *Perichaeta* a large number of small and separate nephridia. He referred in this paper to my own simultaneous discovery of a similar condition in another species of that genus. These results were published later; I showed that in one species of *Perichaeta* there were a large number of external excretory pores, perhaps a hundred or so in a segment; later still the funnels of these were discovered. My results and those of BENHAM were confirmed by SPENCER for a large Cryptodrilid from Australia—*Megascolides australis;* but SPENCER, in addition to the network of small tubes with many external pores, found in the posterior segments of the body a series of larger tubes with funnels not possessed by the smaller tubes. Since these various papers were published a large number of species of earthworms have been described which possess an excretory system of this type, which has been called by myself 'diffuse' and by BENHAM 'plectonephric'. It characterises some or all of the species of the following genera (those in which all the species have a plectonephric excretory system are marked by an asterisk): *Perichaeta**, *Megascolex**, *Octochaetus**, *Deinodrilus**, *Plagiochaeta**, *Benhamia**, *Trigaster**, *Cryptodrilus*, *Megascolides*, *Digaster**, *Microdrilus**, *Dichogaster**, *Typhoeus**. All these genera, it will be noticed, are members of three families—Perichaetidae, Acanthodrilidae, Cryptodrilidae, which I unite here into one super-family Megascolicidae. In no other worms is this condition of the nephridial system met with, though I shall point out later, some Eudrilids are provided with an integumental nephridial network which is somewhat analogous.

The naked eye characters of the excretory system of this kind are very obvious; the absence of the large paired tubes cannot be passed over, and the delicate ramifying tubes especially attached to the septa can hardly be missed, at any rate in well-preserved specimens; very often these tubes are massed into the semblance of paired nephridia, three or more pairs to a segment; this is often seen among the Acanthodrilidae; in the Perichaetidae, on the other hand, the network is more diffuse and not broken up into separate masses. In *Megascolides* and also in *Megascolex armatus* the diffuse network of minute tubules is reinforced by the existence of larger paired tubes, one pair to each segment. These large paired nephridia appear to be in connexion with the smaller tubes.

Fig. 9.



MEGASCOLIDES.

(After Spencer.)

A portion of execretory system of two segments. 1. Nephridial tube in body-wall. 2. Funnel. 3. Septum. 4-6. Nephridial tubes cut in various directions. 7. External pores.

In *Octochaetus* there seems to be no connexion from segment to segment of the nephridia, though the nephridial mass of, at any rate, each side of each segment forms a perfectly continuous network; there are no funnels in the anterior region of the body, and the external pores are not so numerous as they are in *Perichaeta*. In the hinder region of the body the nephridia are also, as will be described more at length presently, connected with the gut; and the excretory system of this part of the body differs from that of the more anterior segments in two points: in the first place there are funnels, and in the second place there is no question at all about a network which is most clear; I have figured this network (**53**), which often becomes so close that the interspaces are mere trabeculae of limited extent, traversing a kind of excretory sinus; the network in the anterior part of the body has rather to be inferred; I have never actually seen a branching of the tubules, but as the orifices to the exterior are numerous, and as there is nowhere any break of continuity, a network must exist; in any case there is no doubt whatever about its existence, in the hinder end of the body. The tubes which lead to the exterior often branch in the thickness of the body-wall, and often run

for some distance in its thickness before opening on to the exterior; in this case they generally run between the two muscular coats.

In *Perichaeta* the nephridial tubules are of finer calibre than in *Octochaetus;* and they are furnished with funnels, which are especially obvious in the anterior region of the body; in this region, apparently in all true *Perichaetae*—it has at any rate been commented upon by many observers—the nephridial mass is much thicker than posteriorly; the septa are here covered with a thick almost furry coating of tubes, which in sections are seen to leave but little of the available coelom free; further back the nephridia are by no means so obvious, a fact which has led to their being described as absent by myself (in *Megascolex coeruleus* for instance); in poorly preserved earthworms they would not been seen by anyone who was not already informed of their existence and therefore unprepared for their excessive minuteness. I have already mentioned that to BENHAM belongs the credit of having first discovered the existence of numerous minute nephridia in a species of *Perichaeta;* from his account it would appear that in this species the several nephridia are quite distinct from each other; this does not seem to be the case in all the species of this genus; in *Perichaeta bermudensis,* for example, it seemed to be undoubtedly the fact that there was a connexion between all the nephridial tubes of a segment, and that in addition to this there was a connexion between the nephridial plexuses of following segments; the tubes were followed through the septa; they appeared to pass into the plexus of the segments in front and behind. The exact arrangement of the nephridial tubes is very difficult to follow on account of their smallness and complicated course, but at any rate SPENCER'S investigations into the anatomy of the excretory system of *Megascolides* led him also to the conclusion that there was a connexion from segment to segment. That there are numerous external pores is a matter capable of being easily proved; if a bit of the cuticle be stripped off, the pores can be easily seen, particularly in specimens which have been preserved in corrosive sublimate; the pores, although small, are far from invisible; it is a matter of interest that there seems to be no regularity in their arrangement; there is no trace of any metameric disposition. The segmentation so clearly visible in most of the organs of the worm's body has here been lost.

The minute structure of the nephridia in those worms which have an excretory system of the diffuse type has been chiefly studied by SPENCER (**1**) and myself (**45**, **47**). Some details about the funnel are to be found in BENHAM'S paper already referred to. As BENHAM has pointed out, the nephridia of *Perichaeta* evidently consist of the three regions described by himself in *Lumbricus;* in *Octochaetus* only two kinds of tubes are to be found.

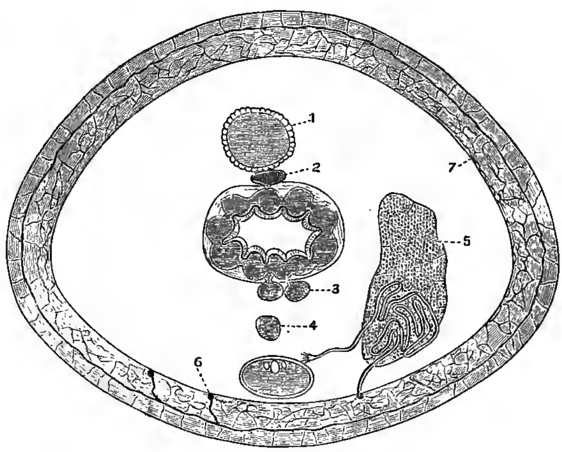
In all of these worms there is no muscular sac at the points of opening on to the exterior; favourable sections are wanted in order to demonstrate the actual pores, since the tubes are of narrow dimensions up to the very opening. Generally speaking, the cells of the epidermis show some peculiarities at the orifices; in *Perichaeta* I have figured the conditions which are found; and SPENCER has figured them in *Megascolides.* The epidermic cells become slightly narrower and converge round the actual orifice, forming possibly a kind of constrictor for regulating the outflow of secreted matter. As already mentioned, the funnels may be present or absent in the diffuse nephridia; when present they do not seem to differ at all from those of the paired nephridia, except that they are generally smaller. BENHAM has carefully described the funnel in *Perichaeta malamaniensis;* there are eight or nine marginal cells, but no central cell nor any centrifugal gutter-cells; the intracellular duct of the tube appears to open at once into the midst of these cells. I have, however, described a horseshoe-shaped funnel in *Perichaeta bermudensis.*

Nephridia of this kind do not exist in any of the aquatic Annelids, nor have they been met with in any other groups of Annelids excepting only the leech *Pontobdella,* where BOURNE has stated that a network exists and is continuous from segment to segment; this statement, however, has been denied.

Integumental nephridial network. The network that exists in certain Eudrilidae is not, I believe, morphologically comparable to the diffuse nephridial system already treated of. This condition of the nephridial system appears to characterise a large number of Eudrilidae, and I have attempted a classification of that family partly based upon the presence or absence of the network. It has been studied most thoroughly in the genus *Libyodrilus.* That worm, like all the other genera of the family to which it belongs, has paired nephridia—a pair to each segment. But the duct leading to the exterior, instead of passing at once to the exterior, branches and forms a complicated network in the integument; in this worm the peritoneal layer which lines the body-wall is, in places at any rate, excessively thick; and in this layer tubes formed by the branches of the ramified external duct run; these put into communication the nephridia of successive segments. The actual details of the way in which this complex network is formed are perhaps subject to some variation. It appeared to me, however, that there were four principal and longitudinally running trunks, symmetrically disposed two on each side of the nerve-cord (corresponding in position to the setae); from these branches arose which ramified in every direction through the longitudinal muscular layer and finally joined a circular vessel running right round the body between the two muscular coats. From this latter fine branches lead to the exterior. These tubes are nowhere ciliated and seem to be not comparable to the coelomic

network of *Perichaeta*, etc., but to be a branching of the epiblastic duct of the nephridium. The duct of the nephridium of *Allolobophora* is said by VEJDOVSKY (**9**) to branch in the integument, and I have already referred to the way in which that duct runs for a considerable distance between the two muscular coats before opening on to the exterior. In some few of the genital segments it seemed to me that the paired nephridia in *Libyodrilus* were absent, but that the network was present. One cannot help being reminded by these facts of the excretory system in the Nematoda and the Acanthocephala; in both these groups the excretory system seems to occur in the shape of tubes running in the integument; the Lemnisci of the Acanthocephala (and an homologous structure has been described in certain Nematodes) are processes of the body-wall occupied by a quantity of tubes which are doubtless of an excretory nature. Eliminate the paired nephridia of *Libyodrilus* and the remaining part of the excretory system would be exceedingly like that of the two groups of worms referred to. To a certain extent I have followed the development of the excretory organs in *Libyodrilus;* the integumental network is, as one would suppose, a secondary development; the first part of it to appear is a continuous longitudinal duct on each side connecting the nephridia of following segments. I imagine that VEJDOVSKY is correct in regarding the longitudinal duct connecting the nephridia of *Lanice conchilega* (described by MEYER[1] and CUNNINGHAM[2]) as formed out of the terminal epiblastic part of the nephridia—the 'bladder' of the nephridium of *Lumbricus*—which have become fused together; it is therefore of some interest to note that a similar single connexion is first developed in *Libyodrilus.* The fabulous (?) connecting duct of *Polygordius* is perhaps of the same nature.

Fig. 10.



LIBYODRILUS INTEGUMENTAL NEPHRIDIAL NETWORK.

1. Dorsal blood-vessel. 2. Supra-oesophageal blood-vessel. 3. Infra-oesophageal blood-vessel. 4. Ventral blood-vessel. 5. Nephridium. 6. One of longitudinal trunks of integumental network. 7. Fine canals of network.

The genera *Megascolex* and *Megascolides*—probably others will be discovered when

[1] Quoted by Lang in his monograph on the Polyclada in Fauna u. Flora des Golfes von Neapel.

[2] On some points in the Anatomy of Polychaeta. Q. J. Micr. Sci. vol. xxviii.

the finer anatomy of earthworms is better known than it is at present—are in their excretory system to some extent intermediate between the Megascolicidae that have just been described and those in which the nephridia are paired; there is a network of fine tubes, but in addition to this a pair of larger nephridia which have a funnel opening into the segment in front of that in which the tube lies; a more remarkable intermediate condition exists in those Cryptodrilidae which I place in a separate genus *Trinephrus*, the name being suggested from the fact that they have three pairs of nephridia in each segment of the body; at present, however, the finer anatomy of these worms is unknown, and we do not know the exact structure of these nephridia; a second intermediate condition is offered by the Geoscolecid genus *Brachydrilus*. In this worm there are two distinct pairs of nephridia in each segment of the body.

Finally, we have those forms in which there are only a single pair of these tubes and they form the majority; they include all the aquatic families, the Lumbricidae, the Geoscolicidae (except *Brachydrilus* already referred to), all the Eudrilidae (where, however, there is an integumental plexus to be referred to), and many of the Megascolicidae, the following genera (those genera in which all the species have paired nephridia are marked with an asterisk): *Diporochaeta**, *Perionyx**, *Acanthodrilus**, *Cryptodrilus*, *Megascolides*, *Ocnerodrilus**, *Gordiodrilus**, *Pygmaeodrilus**, *Pontodrilus**, *Microscolex**.

Connexion of nephridia with the alimentary canal. There are among the Oligochaeta various organs of a glandular nature, opening into the alimentary canal, which in some cases are certainly, in others probably, more or less modified nephridia. These organs are invariably connected with either the front or the hind end of the canal; that is to say, they never communicate with that section which is undoubtedly of hypoblastic origin. At the same time it cannot be said with absolute certainty that those sections of the gut into which they do open are either stomodaeum or proctodaeum; unfortunately embryological data are at present too scanty to permit of a definite statement upon the point. In the present section I shall only deal with those glandular appendices of the alimentary tract which are certainly, or very probably, of nephridial nature; I deal later with such organs as the calciferous glands which cannot, with either probability or certainty, be referred to that category.

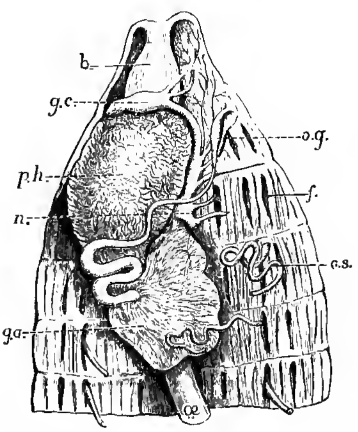
1. *Peptonephridia.* I accept BENHAM'S term for nephridia opening into the anterior section of the alimentary canal; it seems probable that their function is in relation to that of digestion. Such organs occur in more than one family of the Oligochaeta. They were first made known in the Enchytraeidae, and

have since been described in the Acanthodrilidae, Eudrilidae, Cryptodrilidae, and Geoscolicidae.

In the Enchytraeidae they are the so-called salivary glands, which have been described by VEJDOVSKY, MICHAELSEN, and others; in certain species of this family there are a pair of tubes which are more or less branched, opening into the alimentary canal behind the pharynx; sometimes the apertures are lateral in position, sometimes they are dorsal and ventral respectively. The principal reason for considering these tubes to be of nephridial nature is their minute structure; they have a lumen which is undoubtedly intracellular; it is, however, necessary to be careful not to be too much influenced by a consideration of this nature; the calciferous glands, for example, are in some worms folded in so complicated a fashion that the lumen becomes intracellular; the lumen of the blood-vessels is also intracellular; it has been shown that minute vessels are formed by the canaliculisation of cells (by LANKESTER in the Leech). The salivary glands of the Enchytraeidae, however, differ from nephridia in having no opening into the coelom; there is not the least trace of a funnel. Perhaps this fact is not of first rate importance as an argument against their nephridial nature; but it must be considered. Moreover the tubes are not ciliated; this again is against any homology with nephridia; in no Oligochaetous worm are there nephridia which are entirely without cilia; it frequently happens that a greater or less section of the nephridia is devoid of cilia; but the non-ciliated area is restricted. The segments which are occupied by these salivary glands are devoid of other nephridia; this, at first sight, suggests the metamorphosis of the missing nephridia into the salivary glands; but it must be remembered that in the Enchytraeidae, as in most other of the lower Oligochaeta, the nephridia are defective in the anterior segments of the adult worm. On the whole, it seems that the nephridial or non-nephridial nature of the salivary glands of the Enchytraeidae must be left an open question. It is quite otherwise with those earthworms in which similar salivary glands occur. The first description of nephridia opening into the anterior part of the alimentary canal in an earthworm was by myself in *Octochaetus multiporus;* in this worm there are lying along the pharynx a pair of tufted organs which end in a duct of some dimensions; this duct runs forward and opens into the buccal cavity; here again one objection to the nephridial nature of these glands is the fact that they do not appear to be furnished with any coelomic pore. This statement, however, only applies to the glands in the adult worm. Fortunately in this particular instance the development has been traced and I have found that these compact glands are really formed by the fusion of at least two pairs of nephridia which are at first distinct and each provided with its own coelomic funnel. There

is in fact no room for doubt that these 'salivary glands' in *Octochaetus multiporus* are nephridia, modified doubtless to perform some function other than that performed by the nephridia in the other segments of the body—though physiological observations are wanting as to what this function is. In *Rhinodrilus ecuadoriensis* BENHAM has described the first pair of nephridia as somewhat different in appearance from the remaining organs and as opening into the buccal cavity. Such glands also occur in *Acanthodrilus annectens* and in its near ally *Acanthodrilus paludosus*. In certain earthworms there are a pair of large nephridia occupying the first two or three segments of the body, which appear to resemble those of *Octochaetus* already described; such glands occur in *Pontoscolex* (see woodcut), where they were originally termed by PERRIER 'glandes à mucosité'; I showed that these organs are undoubtedly nephridia; they do not, however, actually open into the gut, but so near to it that when the anterior segments are, as is occasionally the case in this worm, inverted, the orifice is actually sheltered by the inversion. These glands cannot be really distinguished from the 'peptonephridia' of *Octochaetus*, etc.

Fig. 11.



PONTOSCOLEX CORETHRURUS.

(After Perrier.)

g.c. Cerebral ganglia. *b.* Buccal cavity. *p.h.* Pharynx. *œ.* Oesophagus. *g.a.* First nephridium ('glande à mucosité'). *o.g.* External orifice of same. *o.s.* Second nephridium. *n.* Nerve cord. *f.* Vacuities in muscular layer for implantation of setae.

SPENCER described in the Australian *Megascolides australis* a number of fine tubes opening into the buccal cavity, which are clearly nephridia; in that worm the nephridial system is of the diffuse kind; and the tubes lying in the anterior section of the body open into the buccal cavity. The difference between the condition which characterises this worm and that found in *Octochaetus* is simply that there are numerous openings instead of only a single one on each side. It seems reasonable to suppose that the two organs are referable to precisely the same category. Curiously enough the same presence of numerous nephridial tubes opening into the buccal cavity occurs in the Eudrilid *Libyodrilus;* in that worm there is a fine network of tubes in the walls of the buccal cavity, opening here and there into the interior of that cavity. In all these cases it will be observed that the nephridia which are connected with the anterior part of the alimentary canal show precisely the same modifications as the nephridial tubes which are not so connected, but which open directly on to the exterior. There are in both cases paired and diffuse nephridial tubes. There can be no doubt, it would seem, that the buccal cavity of these tropical earthworms, like

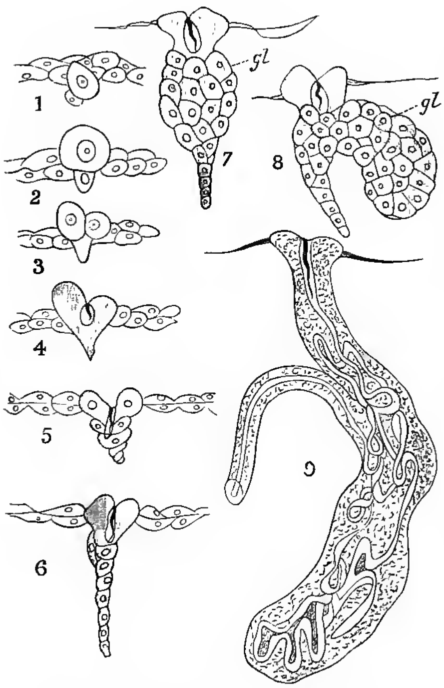
that of *Lumbricus*, is stomodaeum ; hence there is nothing remarkable in the fact that nephridia open into the buccal cavity instead of the exterior, for the buccal cavity is morphologically external. In the case of *Octochaetus* the correspondence is even clearer; for in that worm the massive Peptonephridia, though they only possess a single aperture apiece into the buccal cavity, open also on to the exterior of the body and as in the case of the nephridia of the succeeding segment by numerous pores. The development, however, happens to show that it is the openings into the buccal cavity which are the primitive openings, the numerous external pores being secondary. The relationship of the modified anterior nephridia to the 'head kidney' of the embryo has already been dealt with.

2. *Anal nephridia.* Not only are there undoubted nephridia connected with the anterior end of the alimentary canal; but in one species of Oligochaeta there are undoubted nephridia connected with the rectal region. In *Octochaetus multiporus* I found that a few segments at the posterior end of the body are filled with a dense mass of nephridial tubes which open both directly on to the exterior and into the rectal part of the gut; I am not, however, certain as to whether this part of the gut is or is not proctodaeum. On the whole, the facts which I was able to get together as to the development of this part of the nephridial system seemed to show that the section of the gut into which they open is not proctodaeum; on the other hand, probability seems to urge that it is. A remarkable fact about these anal nephridia in *Octochaetus* is, that they are provided with numerous coelomic funnels. Elsewhere the nephridial system of this Annelid is not in the adult provided with funnels; the tubes form a branching network, very easy to demonstrate as a network, which communicates from segment to segment and also communicates with the exterior through numerous pores upon the integument; there is thus a direct communication between the interior of the alimentary canal and the exterior through the nephridia; the nephridial tubules, when they approach the lumen of the gut, open into wider passages, which have a lining of cells precisely like those of the gut; it would appear that these latter are really diverticula of the gut, though here again the actual development has not been worked out. The occurrence of these nephridia opening into the gut is interesting when they are compared with the respiratory trees of *Bonellia* and its allies among the Gephyrea. I have also suggested a possible resemblance to the Malpighian tubes of the Arthropoda. The comparison here would be of course with the terminal wider tubes with an intercellular duct into which the actual secretory portion of the tubes open. So far as it is at present known *Octochaetus multiporus* is the only Oligochaet which possesses anal nephridia.

§ 3. *Development of permanent nephridia.*

The development of the permanent nephridia out of the pronephridia has been followed by VEJDOVSKY (9) in *Rhynchelmis* and in various species of Lumbricidae. In the former genus the postseptal part of the pronephridium gets thicker and a lobe (woodcut, fig. *gl*) is formed which lies to the side; the distal part of the pronephridium remains unaltered; in this condition the nephridium recalls that of the Enchytraeidae. The pronephridiostom, originally consisting of one cell with a flagellum, becomes multicellular, ultimately consisting of eight cells; these become ciliated and the long flagellum vanishes; but it coexists for some time with the cilia. The vacuole of the pronephridiostom becomes the cavity of the funnel, which comes to open into the coelom and the tube following is gradually excavated. The last part of the permanent nephridium to appear is the epidermic, contractile, terminal bladder. Occasionally in the course of development secondary funnels appear, a course of development which recalls the formation of many funnels in some of the 'plectonephric' worms. In the Lumbricidae the distinction between the pronephridium and the nephridium is not so marked because of the absence of the vacuole and the flagellum in the pronephridiostom; but in these worms, as in *Rhynchelmis*, the main part of the permanent organ appears as a lateral outgrowth of the pronephridium; the original straight tube leading to the exterior remaining more or less unaltered, the alteration concerning the formation of a hollow tube out of it. It has been said by BERGH that there is no epidermic invagination to form the contractile bladder of the nephridium of *Lumbricus;* but this is denied by VEJDOVSKY. There is evidently a greater break between the pronephridia and the permanent nephridia in *Rhynchelmis* than in *Lumbricus*. This is emphasised by the existence of the flagellum in the former.

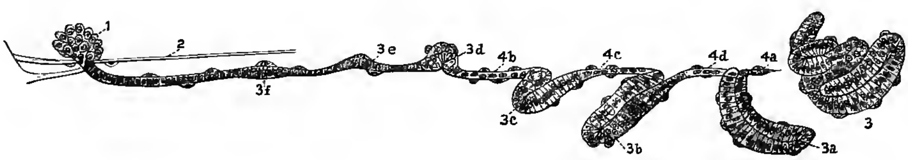
Fig. 12.



DEVELOPMENT OF NEPHRIDIA OF RHYNCHELMIS.
(After Vejdovsky.)
The stages are numbered consecutively. *gl*. Lobe forming chief part of Nephridium.

The development of nephridia of the plectonephric type has been investigated by myself in *Octochaetus multiporus*. There is no doubt that the numerous nephridial tufts of the mature worm with their numerous openings on to the exterior are produced by the growth of a paired series of organs, which, as VEJDOVSKY thinks, are probably the equivalents of the pronephridia of *Lumbricus*. These paired nephridia, however, are provided with well-developed and ciliated nephrostoms; and in their course they are much coiled upon themselves before reaching the external pore. The first pair are anomalous from the very earliest stage in which I studied them. They occupy at least two segments as does the 'head-kidney' of other species, and they open, not on to the lateral body surface but into the commencement of the stomodaeum. A little later in the course of development these first pair become fused with the second pair and the pore is more definitely within the stomodaeal cavity, from which a tubular outgrowth appears to have

Fig. 13.



DEVELOPMENT OF NEPHRIDIAL TUFT OF MEGASCOLIDES.

(After Vejdovsky.)

1. Funnel. 2. Septum. 3. Nephridial tufts in various stages. 4. Connecting tubes finally (4 a) degenerating.

arisen to meet the duct of the nephridium. Thus the 'mucous gland' of the adult worm is a compound structure representing two nephridia of successive segments. The funnels of all the pairs of pronephridia, at first functional, degenerate later; the cilia disappear and the row of cells which forms the funnel becomes more than a single cell thick. The lumen of that part of the nephridium also which immediately follows the funnel vanishes and a solid string of cells is left.

The development of such nephridia has also been studied by VEJDOVSKY (4) in the Australian earthworm *Megascolides australis*. There appears to be no doubt that in this species there is (see accompanying woodcut) to begin with a pair of nephridia to each segment; these have a funnel and from the funnel leads a straight duct not perforate; here and there the cells become larger and finally form loops; these loops ultimately increase in size and become complicated coils, the connecting part of the original tube

degenerating into a mere strand of connective tissue. The last step is the absolute severance of the connexion. Thus it appears firstly that the nephridial system of this worm originates from a pair of pronephridia to each segment; and that this becomes broken up into a large number of nephridia of which one only, the large nephridia described by SPENCER, retains the funnel. If there is, as has been described by SPENCER, a plexus formed by the interconnexions of the small nephridia it must be secondary; but at any rate it is noteworthy that at first when the several nephridia are in course of formation out of the pronephridium there is a connexion at least between the numerous nephridia of the same segment. As to the continuous longitudinal ducts described by SPENCER the most careful search failed to show them in the embryo; they also must therefore be secondary structures.

§ 4. *Phylogeny of excretory system.*

The facts just detailed concerning the development of the plectonephric system might appear at first sight to argue for the theory that this condition is secondary and that the paired nephridia of *Lumbricus*, &c. are to be looked upon as the primitive condition. The facts seem to negative my view, supported by SPENCER and BENHAM, that the paired nephridia of the majority of Oligochaeta are formed by reduction from a network such as now exists in *Perichaeta* and many other genera. Before any developmental facts were known this course of evolution seemed to be supported by many considerations. In the first place a progress from a more generalized to a more specialized condition is seen in the evolution of other organs. Then there are certain resemblances between the network nephridia and the excretory organs in the Platyhelminths. Traces of the supposed primitive condition also existed in those worms which are now provided with the paired form of excretory organ; thus in *Anachaeta* the nephridium has occasionally more than one funnel; in many forms there is a branching and anastomosis of the fine tubes of the nephridium, for example in *Microchaeta*, to which reference has already been made, and in other forms also. This view must evidently be now given up; but, on the other hand, it is not by any means permissible to adopt the converse view already suggested. It does not follow that the diffuse nephridia are the outcome of a branching and specialization of the paired nephridia; on the contrary the developmental facts absolutely disprove this. What they do prove is that both paired and diffuse nephridia are formed out of similar pronephridia; that in fact both kinds of excretory organs are equally ancient. This opinion, practically arrived at by myself after the study of the development of *Octochaetus*, was more definitely formulated by VEJDOVSKY (9).

It is clear too from the fact that the diffuse and paired form of the excretory system occur in forms which are so nearly related, for instance in *Acanthodrilus* and *Octochaetus*, that there can be no profound gap between the two kinds of organs. The 'Plectonephrica' of BENHAM I agree with VEJDOVSKY in considering an artificial group.

V. ALIMENTARY CANAL.

The alimentary canal in all Oligochaeta consists of a straight tube running from the mouth which opens on to the first segment and is overhung by the buccal lobe[1] (when present) to the posteriorly situated anus; with two exceptions the anus is surrounded by the last segment of the body. These exceptions are *Criodrilus* and *Sparganophilus;* in the former worm VEJDOVSKY figures (**24**, Pl. x, fig. 21), seven post-anal segments, and the anus itself as dorsal in position. There is, however, no flexure of the intestine in *Criodrilus;* it passes, as in other Oligochaeta, perfectly straight from the mouth to the anus. Developmentally the alimentary canal of the Oligochaeta, as of other animals, consists of three portions: (1) *Mesenteron*, hypoblastic in origin, (2) *Stomodaeum*, (3) *Proctodaeum*, both formed by later invaginations of the epiblast; of the two the proctodaeum is the later formation. The greater part of the alimentary canal is of hypoblastic origin. The actual extent of the stomodaeum seems rather doubtful. VEJDOVSKY, who at one time thought that the end of the pharynx marked its posterior limit, was subsequently inclined to think that the buccal cavity only was of epiblastic origin in *Lumbricus* and *Rhynchelmis.*

In the adult worms the alimentary canal may be divided into the following regions: mouth and buccal cavity, oesophagus, pharynx, and intestine. The *mouth* is nearly invariably ventral in position[2] and it leads into the *buccal cavity* which is of limited extent; the buccal cavity of the Enchytraeidae is often provided with one or a pair of small tongue-like organs which spring from its floor. These are probably sense organs. MICHAELSEN at one time put them down as playing the part of a sucker. These organs are furnished with minute hair-like processes, and appear to be entirely cellular; they are in fact a product of the lining epithelium of the buccal cavity; in some species they can be everted; in a few species the buccal cavity has a dorsal diverticulum in which the cells are more glandular; this state of affairs occurs in *Benhamia*, in *Microdrilus* and a few more species In the higher Oligochaeta the buccal cavity is separated from the ensuing *pharynx* by a constriction on which lies the cerebral ganglia; in *Aeolosoma* there appears

[1] A few exceptions where the intestine is spiral are noted under the description of that organ.

[2] Terminal where the prostomium is absent.

to be no buccal cavity at all but the mouth leads at once into the pharynx. The latter has usually exceedingly muscular walls, the musculature being dorsal; the lumen is folded and ciliated, in the lower Oligochaeta, and dorsally, as BENHAM has lately pointed out in the earthworms—at least in many earthworms. In *Perichaeta* the buccal cavity is markedly capable of extrusion; to a less extent this is also the case with other Oligochaeta. The pharynx, on the other hand, is not to be extruded. After the pharynx comes the oesophagus; this is a tube of moderate calibre which extends through a varying number of segments. The *oesophagus* is always ciliated in the lower Oligochaeta but not throughout its whole extent in the earthworms; the cilia usually begin after the calciferous glands, if these are not present in the hinder region of the tube; thus in *Libyodrilus* the cilia begin in segment xiv. The oesophagus is the most specialized part of the alimentary tract in correspondence with the cephalization exhibited by the other organs which lie in the anterior region of the body. The pharynx is often supplied with glands which have been variously termed 'salivary glands,' 'septal glands'; they are not to be confounded with 'salivary glands' of apparently nephridial origin which are treated of under the excretory system.

The septal glands (at one time mistaken for ganglia of the visceral nervous system) are especially conspicuous in the aquatic Oligochaeta, where they are attached to the septa, whence of course the name; they are masses of pear-shaped cells, each cell being prolonged to form its own duct; the ducts appear to enter the pharynx. VEJDOVSKY has figured very obvious glands of this kind in the embryo *Allolobophora*.

These septal glands seem to me to be simply epidermic glands which have been invaginated along with the stomodaeum; they are appended to a part of the alimentary tract which must be, though the actual proof is in most cases wanting, of epidermic origin; in this case the glands will be entirely comparable to those which open on to the genital papillae of the Perichaetidae, or in fact to the glandular cells of the clitellum. On the other hand their position upon the septa and lying freely within the coelom seems to be against this interpretation, and in favour perhaps of regarding them as homologous with the septal sacs of certain species of *Perichaeta* and *Acanthodrilus* referred to above.

Gizzard. In the majority of the Oligochaeta a part of the oesophagus is modified into an organ which is usually called the gizzard; this part of the alimentary canal is distinguished by the immensely thickened muscular walls and by the thick chitinous layer secreted by the lining epithelium. As to the muscular layer, it is the circular fibres which are especially increased. The gizzard is absent in a large number of Oligochaeta, particularly among the mud-living forms; in no family of Oligochaeta

which habitually live in or at the bottom of streams, lakes, etc. is the gizzard present; this fact might, and indeed has, led to the inference that its absence is to be accounted for by the soft nature of the food. Probable though this hypothesis is, it seems to be contradicted by the fact that the gizzard is also absent in a number of terrestrial Oligochaeta whose food is presumably quite the same as that of other terrestrial species which possess a gizzard. Moreover a gizzard is wanting or rather represented only by a rudiment in a species whose habitual food is harder than that of any other Oligochaeta; in *Pontodrilus bermudensis*, which lives on the sea shore in coral debris (with which its alimentary canal is always full) there is only the trace of a gizzard. *Microscolex* too is a purely terrestrial form but it either has no gizzard or a degenerate one. It is evidently therefore not safe to lay down any such general statement about the cause of the presence or absence of the gizzard. In the greater number of earthworms the gizzard only occupies a single segment; but the segment in which it is found is not always the same; in *Lumbricus*, for example, the gizzard is usually in the xviiith segment; in *Megascolex*, on the other hand, the vith segment is occupied by this organ. Very often there is more than a single gizzard; when this is the case the gizzards are in consecutive segments; the genera *Digaster* and *Dichogaster* have been so named on account of the presence of two gizzards; there are two gizzards also in *Benhamia* and three in the genus called by FLETCHER *Perissogaster*—a genus which is in the present work included in *Digaster*. In the genera *Moniligaster*, *Pleionogaster*, *Hyperiodrilus*, *Heliodrilus*, and one or two others, there are a considerable number of gizzards—three to ten in number.

The genus *Perichaeta* is remarkable for the fact that it is provided with only a single gizzard, which nevertheless occupies two segments. It seems to be quite possible that in this case there are really a pair of gizzards which have become intimately fused so as to form a single one.

An important point to be noticed about the gizzard is that it may occur in any segment or segments of the oesophagus; it has no fixed position except of course for the species or genus as the case may be.

As to the histology of the organ, comparative researches are as yet wanting. It is perhaps remarkable that the muscular tissue which enters into its formation is precisely similar to that of other parts of the body and not striated; it so often happens that the muscular tissue of organs of great muscular power is made up of striated fibres that the negative fact—that this is not the case with the Oligochaeta—is worth calling attention to.

Calciferous glands.—Appended to the oesophageal region of the digestive tract of many Oligochaeta are a series of glands which have been variously termed

'Glands of Morren,' 'Oesophageal glands,' 'Calciferous glands,' etc. The oesophagus in the higher Oligochaeta is usually divisible into two tracts, of which one is more richly supplied with blood-vessels than the other and has a more folded lining epithelium. Frequently this part of the oesophagus is constricted by the septa, and the sections of the tube which lie between the septa are broader than those which are nipped by the septa; hence a moniliform appearance often exists. This is the case for example in the genus *Perichaeta* (s. s.). The specialization of a tract of oesophagus having these characters in a more pronounced fashion is characteristic of the genus *Onychochaeta* and of other forms; in the genus mentioned that portion of the oesophagus which occupies segments xii. to xv. is wider than elsewhere and is provided with markedly regular and deep folds of epithelium; this is a step in advance towards the existence of distinct diverticula of the oesophagus such as exist in a great many genera and species; it is at the same time merely an exaggeration of the vascular tract of oesophagus commonly found in the higher Oligochaeta whether they possess or do not possess distinct calciferous glands.

In *Octochaetus multiporus* the oesophagus is swollen in segment xvii.; in transverse sections of these swellings they are seen to be really diverticula of the oesophagus opening into it by wide apertures on either side. In *Pontoscolex* the three pairs of calciferous glands first investigated by PERRIER are only attached to the oesophagus by their duct on either side; they are otherwise quite separate from it; every stage in fact appears to exist between mere dilatations of the oesophagus and diverticula of it; in the most differentiated form of the calciferous glands, such as are found for example in *Pontoscolex*, the pouch communicates with the gut by a distinct duct whose walls are lined by cells different in character from those which line the gland; it is commonly the case that this duct has a lining of ciliated cells while the cells of the gland itself are not ciliated.

We shall return to a more detailed description of the minute structure of these glands later; at present we are concerned with their distribution in the group. Calciferous glands in some form or other have been found in the following families; those families in which they are nearly or quite universal are printed in capitals; those in which a good many forms are without such glands are printed in clarendon; finally, italics denote that the glands are rarely met with in the family.

LUMBRICIDAE.
GEOSCOLICIDAE.
ACANTHODRILIDAE.
Enchytraeidae.

Cryptodrilidae.
Perichaetidae.
Eudrilidae.

In all the remaining families of Oligochaeta there are no recognizable traces of these glands or of anything that can be compared to them; they are absent in fact in the following:—

Aeolosomatidae.
Naidomorpha.
Tubificidae.
Phreoryctidae.
Lumbriculidae.
Moniligastridae.

It will be seen that the presence or absence of glands appended to the oesophagus is broadly indicative of an aquatic or a terrestrial life; it is by no means absolutely so; for *Moniligaster* is, so far at any rate as is at present known, a purely terrestrial type, much more so than is the family Eudrilidae of which many members are largely aquatic in habit.

There appears, however, to be a much closer relation between the presence of calciferous glands and comparatively large size and complex organization. This generalization is trammelled by fewer exceptions. Certain exceptions will at once occur, notably perhaps the smaller species of *Benhamia* which are among the smallest, if not the smallest, of earthworms; it must, however, be borne in mind that this genus *Benhamia* is not typically composed of small-sized species; on the contrary the average size is large, and some of the biggest earthworms are referable to the genus *Benhamia*. The smaller genera of a given family have frequently a reduced number of calciferous glands. This is best exemplified by the genera *Ocnerodrilus* and *Pygmaeodrilus,* in which there are but a single pair of these glands; so too in *Kerria* among the Acanthodrilidae and *Gordiodrilus* a genus of somewhat doubtful affinities; the Geoscolecid *Ilyogenia* has but one pair of glands, and is withal a small member of its family. In fact it seems that everything points to a decided relation between size and absence or presence of calciferous glands. The relation may be more accurately stated thus:—

Calciferous glands are absent or reduced in number in genera which are entirely composed of small-sized species. When the entire family contains only small-sized genera calciferous glands are completely absent.

It has been asserted that the presence or absence of these glands is in accordance with the nature of the food of the worm; the Limicolae of Claparède are, as their name denotes, mainly dwellers in soft mud or among weeds, and thus contrast with the boring earthworms. This view, however, does not seem to me to be consistent with the facts. A greater knowledge of the life habits of the Oligochaeta may perhaps reveal some relation between the two series of facts, but at present this knowledge does not exist.

A further indication that there is a relation between the glands and the size of the worm where they occur is afforded by the simplification in structure which the glands show in the smaller Oligochaeta. In *Ocnerodrilus* the lumen of the single pair of glands is but slightly divided up by folds projecting into the lumen; glands of this worm have been figured by myself and by EISEN. In *Gordiodrilus* there is a similar simplicity in the minute anatomy of the single unpaired oesophageal pouch found in the worm.

The calciferous glands are limited to the oesophagus; nothing at all resembling them occurs in the intestinal region—except possibly the 'kidney-shaped glands' of *Megascolex coeruleus* and of *Typhoeus* (see below). These latter however are not known to produce calcareous particles such as are secreted by the calciferous glands; a difference of function which this implies is not of course an objection to a serial homology; and it is also true that both oesophagus and intestine are derivatives of the mesenteron. It seems however to be clear that the folded structure of the intestinal glands is not comparable to the folded structure of the calciferous glands, for the latter is simply an expression of the fact that the glands in question are diverticula of the already folded lining membrane of the oesophagus, while the epithelium of the intestine is not folded; hence the complication of the intestinal glands is an independent formation. The calciferous glands vary in number from one to eight pairs; they are nearly always in consecutive segments, but these segments are not fixed. Thus in *Pontoscolex* the glands are in segments vi.-viii., while in *Benhamia* they occupy segments xiv. xv. xvi. as a rule. It seems that after the first segments of the oesophagus any segment is capable of developing calciferous glands. These organs are not always paired. In the Eudrilidae and in the genus *Gordiodrilus* there are median unpaired glands which have the structure of calciferous glands; in *Buchholzia* there is a median dorsal gland.

A remarkable fact about the unpaired glands of the Eudrilidae (as seen for example in the genera *Eudrilus*, *Polytoreutus*, and *Heliodrilus*) is that they coexist with paired glands; this does not however mean that the two glands are in the same segment, but they are so far independent that there is sometimes a break of a segment between the last unpaired pouch and the single pair of calciferous glands. These unpaired glands of the Eudrilidae were first discovered and described by myself in the genus *Eudrilus* (**62**). To these structures MICHAELSEN has given the name of 'Chylustaschen.' He is of opinion that their function is different from that of the paired calciferous pouches. The 'Chylustaschen,' according to MICHAELSEN, are organs not of secretion but of absorption; by their epithelium nutritive matters are supposed to be taken up from the blood. Here again a difference of function does not by any

means necessarily imply a morphological difference; and MICHAELSEN is far from suggesting directly any such difference; the fact however that he gives them a different name would perhaps lead to the inference that there was some difference of structure; MICHAELSEN does not in his descriptions of the minute structure of these glands (**12**) show any differences of importance from the paired calciferous glands of the Eudrilidae and of other Earthworms; there is however a difference which I have noticed and described in *Heliodrilus* and *Hyperiodrilus;* in these two genera, and in all probability in others, the periphery of the glands is occupied by a network of tubes whose lumina are intra-cellular; the rest of the gland shows only inter-cellular lumina. This is however in my opinion not a matter of great importance; the excessive folding of the epithelium of the pouch becomes at length so complex that the lumen inevitably becomes intra-cellular, the folds get to be smaller than the length of a single cell; this at least is my explanation of the matter.

As to the supposed difference of function—it does not exist in every case—I have found that in *Eudrilus* the unpaired glands secrete calcareous particles entirely similar to the particles secreted by the paired gland, and so has UDE (**4**). There are so many instances among the Oligochaeta of organs being paired in one genus and unpaired in another, that a difference of this kind cannot be looked upon as of much importance; the various parts of the generative apparatus are sometimes unpaired, though as a rule paired; the contrary occurs with the dorsal vessel which is as a rule unpaired, but occasionally paired; even the brain is more or less completely divided into two halves. The actual fact as to the paired or unpaired character of the glands is not therefore in my opinion a matter for serious consideration in deciding upon their homology. We may fairly regard them as structures which are serially homologous.

These organs, the paired and the unpaired, consist of a diverticulum of the oesophagus, which is lined by epithelium continuous with that of the oesophagus; as a rule this epithelium is rather different in appearance from that whence it has been derived; the minute structure of the glands has been studied in *Lumbricus* (CLAPARÈDE, **1**), *Pontoscolex* (PERRIER, **5**), *Ocnerodrilus* (BEDDARD, **20**, and EISEN, **1**), *Eudrilus* (BEDDARD, **62**), *Heliodrilus* (BEDDARD, **54**), *Alvania* (BEDDARD, **39**), and in a few other types; *Ocnerodrilus* is the least complicated of these. In that genus the single pair of glands have a capacious lumen which is only moderately divided up by internal folds; the cells lining the diverticula are ciliated, as are those of that part of the oesophagus at least which follows the apertures of the glands into it. Among the Eudrilidae the subdivision of the lumen by numerous anastomosing folds has reached its highest point; and here as in many other species the epithelium is not ciliated; in *Pontoscolex* the epithelium is remarkable for being a low flattened epithelium; it is

elsewhere columnar. In the genus *Pontoscolex* and in most other genera each of the three or more pairs of glands opens by its own separate orifice into the oesophagus. *Lumbricus* (including *Allolobophora*) is an exception to this statement; in that genus, as was at first pointed out by MARSHALL and HURST in their 'Practical Zoology,' the first pair of glands alone open into the lumen of the gut; the two following glands of each side open into each other and into the lumen of the first pair; there is thus but a single orifice into the gut for all three glands; this difference has been emphasised by terming the first pair of glands oesophageal pouches in contradistinction to oesophageal glands. The descriptions of MARSHALL and HURST have been confirmed by KULAGIN (1). One other genus at any rate shows the same thing exactly; I have found that in *Microdrilus* there are three pairs of glands of which the first pair only open into the gut; the remaining two of each side open into the first. A curiously analogous arrangement was found occasionally to exist in *Polytoreutus*; MICHAELSEN discovered that in a specimen of *Polytoreutus coeruleus* the last of the unpaired glands opened not directly into the oesophagus, but into the pouch in front.

An example of the calciferous glands of this type, which are, it will be observed, not distinctive of any one family, is afforded by *Octochaetus multiporus* (see Plate V). In the young just ready to leave the cocoon the glands, which are most conveniently studied in that condition, owing to their small size, form merely a dilatation of the oesophagus. In a series of sections commencing at the head end of the worm the gland comes into view lying above the oesophagus and between the two dorsal vessels; the latter immediately come to lie upon it. Still passing back, the gland gradually extends round the oesophagus opening into it at first in the dorsal middle line, afterwards along other lines. Ultimately the openings into the oesophagus become so frequent that the latter can be no longer distinguished from the surrounding gland; its somewhat more columnar epithelium passes gradually into the lower cubical epithelium of the gland. Only on the ventral surface can the oesophagus be said to exist apart from the gland for there are no ventral folds of the glandular membrane. The entire gland is covered with a layer of peritoneum of which the cells are not so long and pear-shaped as elsewhere. The lining epithelium is arranged in numerous folds some penetrating further towards the lumen than others and being generally thicker at their free edge owing to the fact that the cells are here more columnar. Peripherally the cells are ciliated.

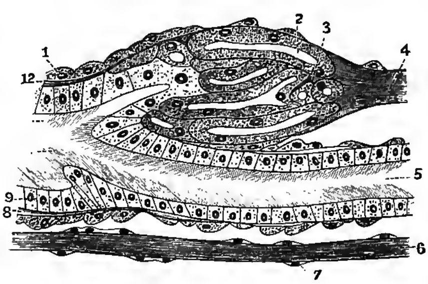
The secretion produced by these glands is in the form of solid particles of calcareous matter; the actual form in which these concretions occur varies somewhat. In *Lumbricus* they are figured and described by CLAPARÈDE as being 'small perfectly spherical bodies with a diameter of from 2–6 micromm.'; in optical properties they

resemble, according to the same author, fat particles; besides these round particles which constitute what is called by CLAPARÈDE 'Kalkmilch,' there are in the first pair of these glands rhomboedra, and larger concretions are figured but not specially described. These latter show radial striations. The large concretions as well as the small spherules are figured by LANKESTER. In *Pontoscolex* PERRIER mentions only the fine spherules. In *Microdrilus* I have found rhomboedral crystals and also in *Eudrilus*. That these particles are formed of carbonate of lime seems to be proved by the fact that they dissolve in acetic acid, giving off carbonic acid.

Besides the glands already described there are other diverticula of the oesophagus which seem to be the equivalents of the calciferous glands, but are of different structure from those described and from each other. The Enchytraeidae have been known since the careful investigations of VEJDOVSKY (**3**) and MICHAELSEN (**1–4**) to possess glands appended to the anterior part of the alimentary tract which have been termed by MICHAELSEN 'Chylustaschen,' and regarded as homologous with the similarly named structures in the Eudrilidae; these occur in two varieties:—

In *Buchholzia* there is a single dorsal pouch from which arises the dorsal blood-vessel; this pouch communicates with the oesophagus by a wide orifice; its interior is however not a simple lumen but is occupied by a mass of tubules or by a single much convoluted tubule, which has the appearance of a nephridial tubule, inasmuch as it has an intra-cellular lumen; the interspaces between the tubules is occupied by blood spaces; from these arises the dorsal vessel; this apparently single pouch is really composed of two closely applied pouches; its lumen is not ciliated.

Fig. 14.



BUCHHOLZIA. CALCIFEROUS GLAND.
(After Michaelsen.)

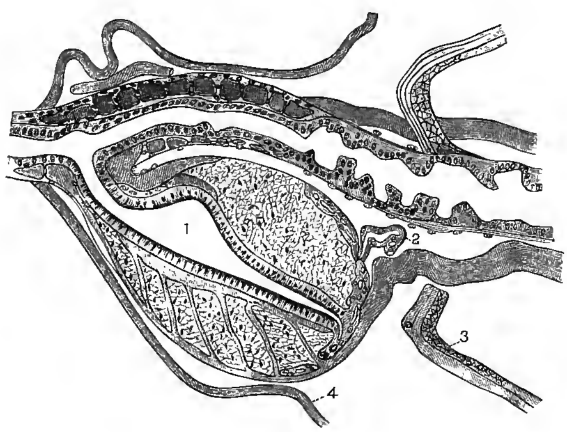
1. Peritoneal layer. 2, 3. Tubules of gland 4. Dorsal vessel. 5. Lumen of intestine. 6. Ventral vessel. 7. Peritoneum. 8, 9. Muscular and epithelial layers of intestine. 12. Vascular sinus of intestine.

In *Fridericia leptodera* there is a pair of diverticula with ciliated lining epithelium, and in *Henlea ventriculosa* two pairs of such diverticula; the degree of folding of the lining epithelium varies somewhat. These structures are obviously related to the diverticula of earthworms, but it is not so certain whether the remarkable glands of *Buchholzia* are.

The latter are to some extent paralleled in another genus, *Gordiodrilus;* in the four or five species belonging to this genus there opens into the oesophagus on the ventral side an ovoid pouch. This pouch is formed in the first place by

a diverticulum of the oesophagus; round the epithelium, which is columnar, is a layer of tissue in which no cell boundaries could be detected; abundant nuclei scattered throughout it appear to show that it is a mass of cells; these cells are filled with oval or round particles like those which occur in the peritoneal cells in many parts of the body, particularly upon the nephridia. This mass of tissue is not separated from the epithelium by any membrane of any kind; the epithelium rests directly upon it; it is traversed in various directions by blood-vessels; towards the blind end of the pouch this layer gets thinner; at this end the lumen of the gland becomes intra-cellular; the periphery of the gland in fact is formed of a network of tubules exactly like nephridial tubes, but they are not ciliated, so far as I have been able to discover. It is a question as to whether the mass of cells covering the lining epithelium is peritoneal or is a specialization of the lining epithelium; I believe the latter interpretation to be the right one; as to the peripheral network of fine tubes I recur to the matter later. These glands or gland—for they may be paired or unpaired—are very different in many points from the calciferous glands of earth-worms or from the pouches appended to the gut in the Enchytraeidae. They are perhaps best to be compared with a series of structures which characterise certain Eudrilidae.

Fig. 15.



GORDIODRILUS. CALCIFEROUS GLAND.

1. Lumen. 2. Nephridium apparently in connexion with gland. 3, 4. Septa. The blood-vessels and the vascular plexuses are shaded.

In the systematic part of this work I divide the Eudrilidae into two groups, in one of which there are calciferous glands and three unpaired pouches of the same structure; in the remaining set the place of these is taken by a greater number of paired bodies, closely applied to the oesophagus. These glands were first described by myself in the genus *Eudriloides;* they have also been found in *Stuhlmannia* and a few other genera. They consist of a mass of tissue exactly like that which surrounds the lining epithelium of the pouch in *Gordiodrilus;* this mass of tissue likewise surrounds a lumen which opens into the oesophagus (in *Eudriloides* at any rate); this lumen, however, is of very limited extent; it does not nearly traverse the whole

of the glands, but ends very soon. The mass of cells surrounding it appears to be white in the dissected worm owing to the immense amount of minute spherical particles; the cells are in places specialized, and get a certain resemblance to columnar epithelium; this alteration takes place round a blood-vessel; the effect produced is that of a gland tube cut across, the lumen of which is filled by blood; the tissue in these modified tracts stains deeply with borax carmine; elsewhere it is hardly at all stained by that re-agent; this is of course due to the absence of secreted particles which are so abundant in the non-staining regions. I shall again recur to these glands in connexion with the blood glands of the Oligochaeta. Whatever the function of these glands may be, it does not appear to be exactly that of the calciferous glands of other Oligochaeta, for calcareous particles were never found in the lumen of the glands. They seem, however, to be in all probability serially homologous with calciferous glands; I never found the two kinds of glands to co-exist in the same species; and the glands now under consideration are clearly diverticula of the oesophagus as are the true calciferous glands. I believe that the mass of cells which surrounds the feebly developed epithelial lining is peritoneum, which has increased in amount *pari passu* with the gradual reduction of the glandular secreting surface, and has changed the function of the organ. Apart altogether from function, which is not now the question, these glands must from their position, and from the fact that they are diverticula of the oesophagus, be referred to the same category as the calciferous glands of other Oligochaeta.

Intestine.—The oesophagus widens out to form what has been called the large intestine; the exact segment at which this begins varies a good deal; it is earlier or later as the case may be; as a rule in the more simply organized forms it is more anterior than in the more complex species. The large intestine not only differs from the oesophagus by its greater calibre, but by various details of structure, not always, however, present. The most characteristic feature is the typhlosole; the typhlosole is a median fold of the dorsal wall of the gut, which projects into its interior and diminishes the lumen while it increases the secretory surface. The degree to which the typhlosole is developed varies greatly; in the lower Oligochaeta it is entirely absent; it is also absent in a few of the more simple terricolous forms such as *Ocnerodrilus*. It has been often stated to be absent in *Perichaeta;* as far, however, as my experience goes, it is not absent in that genus, but very feebly developed, forming a slight fold which projects for but a short distance into the lumen of the gut. The complications in the typhlosole vary in different species; in *Octochaetus* it is a fold which reaches nearly to the ventral surface of the gut and is trifid at the free edge; an equally deep fold exists in *Deinodrilus*

benhami, but it is not trifid. At a varying distance from the anus the typhlosole ceases; I have figured its abrupt ending, in the Acanthodrilid *Octochaetus multiporus*. After this point the term rectum may be applied to the gut.

The large intestine is generally a straight tube running without a bend from commencement to termination; in a few forms, however, it has a spiral arrangement; this is seen in *Plagiochaeta*, and, according to HORST, in *Pontoscolex corethrurus*. In the course of the tube it often exhibits a specialization into several regions; in *Megascolex coeruleus* this is especially evident—perhaps to some extent on account of the large size of the worm rendering the various regions more evident than they would be in a small species. In the first six segments the intestine is deeply pouched; in the twenty-second segment the pouches became deeper still; they extend to about the seventy-sixth segment; in several Oligochaeta the intestine commences in this way with a series of deepish pouches; for instance, in *Urobenus brasiliensis* (BENHAM, **3**), where, however, it only extends from segment xvi. to xxv. In *Megascolex coeruleus* there are a series of glands appended to the intestine and lying beyond the pouches; these are the 'kidney-shaped glands' of my description of that Annelid; they were also found by BOURNE in his specimens; the actual number of pairs of these glands appears to vary as both BOURNE and I give different numbers. Their structure is quite simple; they have the appearance of being formed by a much folded membrane; it is a matter of some interest from a classificatory point of view that entirely similar glands occur in the genus *Typhoeus* belonging to the family Cryptodrilidae. Otherwise they are unknown in the Oligochaeta. The number of pairs is less in *Typhoeus*. Highly characteristic of the genus *Perichaeta*, but also, strange to say, found in the apparently remotely allied *Urobenus*, are a pair of caeca of the large intestine; these occur nearly, if not absolutely, always in the twenty-sixth segment; they are directed forwards, and occupy two or three segments. A few species of *Perichaeta*, for example *P. sieboldi*, have a mass of six or seven of these caeca arising close together and appearing to be formed by the branching of one caecum. In *Urobenus* the caeca are in the same segment. In the remarkable Cryptodrilid *Millsonia* there are more than thirty pairs of caeca precisely like those of *Perichaeta*.

VI. VASCULAR SYSTEM.

The Oligochaeta agree with the Polychaeta in possessing a *closed vascular system*, i.e. one having no communication with the body-cavity (coelom). Unlike what is found in the Polychaeta there are no Oligochaeta known which have not a vascular system, though the complication of the vessels belonging to this system

varies in the different groups; they are more complex in the larger forms and on the whole less so in the smaller worms.

§ 1. *Histology of blood-vessels.*

The blood-vessels of the Oligochaeta are tubular, rarely lacunar; the larger vessels, some of which are contractile, have thicker or thinner walls, and give rise in the higher Oligochaeta to an extensive system of capillaries. In the larger vessels circular as well as longitudinal muscular fibres exist and the vessels are lined by an epithelium and covered by the cells of the peritoneal investment. There is an increase in the elaboration of structure of the principal (dorsal) blood trunk, as we pass from the lower to the higher Oligochaeta. In *Aeolosoma* the dorsal vessel consists, according to VEJDOVSKY, of no more than an exceedingly fine membrane, in which no structure, muscular or other, could be detected; it is covered of course by the peritoneum. Very little more can be said of the Naids and Enchytraeidae; there is simply a delicate membrane covered with peritoneum. In *Chaetogaster*, however, which I reckon a Naid, it is possible to recognize faint longitudinal as well as transverse striae. Something similar is figured by TAUBER (**3**, Tab. iii, fig. 11) for *Nais elinguis*, and VEJDOVSKY figures (**24**, Tab. iv, figs. 20, 21) and describes contractile cells (besides the peritoneal cells, with which they must not be confused) as constituting the walls of the dorsal vessel of *Stylaria lacustris*. One is inclined to suppose that the dorsal vessel of *Aeolosoma*, since it is contractile, will prove to possess muscular fibres. In the forms that have been hitherto considered there seems to be no definite lining of epithelium to the dorsal vessel. In the higher Oligochaeta, on the other hand, the epithelial lining consists often of very large and conspicuous cells. In *Phreoryctes*, for example, I have figured (**18**) a transverse and longitudinal section through one of the perioesophageal vessels (which have the same structure as the dorsal vessel) which show (Figs. 8, 9 of plate) the cubical cells lining the lumen of the vessel; the strong circular and longitudinal muscular layers of the vessel are also shown. VEJDOVSKY'S figures (**24**, Taf. xiv, figs. 10–13) show the lining epithelium and at any rate a circular layer of muscles in *Criodrilus lacuum;* while PERRIER has recorded a similar structure for *Urochaeta*. Naturally the circular[1] layer is much more important than the longitudinal, and it has therefore been often the only one figured. The blood itself is usually red; yellower in Naids, and colourless in *Aeolosoma*[2]. The colour, as was first shown by LANKESTER, is due to haemoglobin.

[1] Both circular and longitudinal fibres are described in the text (p. 118).

[2] Lankester says that it is *pink* in *Ae. quaternarium.*

The blood contains minute corpuscles suspended in it which are little more than the nuclei of the lining cells.

The blood-vessels of the Oligochaeta are often provided with valves. These, however, are limited to the dorsal vessel and to the hearts. They do not appear to occur in the lower Oligochaeta—unless indeed the cardiac body of the Enchytraeidae is derived from a fused series of valves such as occurs in Vertebrates—with the exception of *Phreoryctes,* where they have been described by LEYDIG (**6**) and by TIMM in the dorsal vessel. In earthworms they are very general, probably universal. I have myself found them wherever I have looked for them. In the dorsal vessel they occur just where the vessel traverses the septa; in the hearts they may occur all along (cf. e.g. PERRIER, **5**, Pl. XV, fig. 29) from its point of origin from the dorsal vessel up to the opening into the ventral vessel. The valves are essentially proliferations of the lining membrane of the blood-vessels, the cells forming them being large and granular. The blood gland of *Phreodrilus* may very possibly be regarded as homologous with a fused series of valves, unless the interpretation which I have suggested in describing it be accepted in preference.

§ 2. *Main trunks.*

The principal longitudinal trunks in the Oligochaeta are five, all of which do not exist in the lower forms; they will be now considered seriatim.

The Dorsal vessel. — This, the principal of the longitudinal trunks, is present in all Oligochaeta and is invariably contractile; it is not, however, always equally well developed; for in some forms (e.g. *Aeolosoma*) it is deficient posteriorly while in others (e.g. *Chaetogaster cristallinus*, *Rhinodrilus ecuadoriensis*, qq. v.) it terminates a little way before the anterior end of the body. In nearly all those forms where the dorsal vessel is fully developed, which include the great majority, it passes from one end of the body to the other upon the dorsal surface of the alimentary canal; in *Branchiura*, however, and in *Dero* this is only true of the anterior section of the tube; posteriorly it comes to lie on the ventral surface of the body, near to the ventral vessel. The dorsal vessel is commonly separated by a little distance from the actual walls of the canal, but along the intestine it closely invests the gut; it is not, however, in the higher Oligochaeta, covered by the intestinal peritoneum, but has a layer of peritoneal cells to itself.

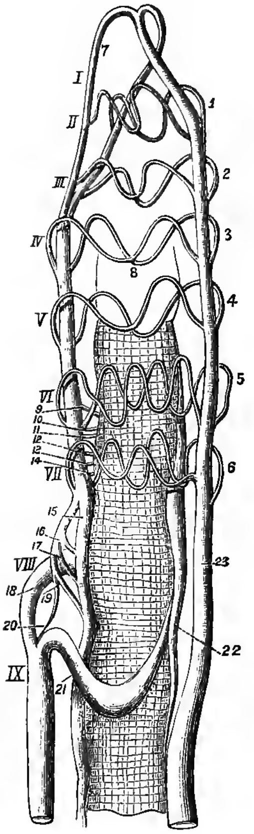
The way in which the dorsal vessel terminates anteriorly varies in different Oligochaeta. As regards the higher Oligochaeta we have two elaborate memoirs

dealing respectively with *Pontoscolex* and *Megascolex* by PERRIER and BOURNE. The following account is deduced from these two memoirs. In *Megascolex* the dorsal vessel bifurcates anteriorly in the first segment of the body; each of the two branches into which it divides is the equivalent of the succeeding dorso-tegumentary vessels, and like them forms a peripheral vascular network which only communicates indirectly with the ventral vessel. In *Pontoscolex* (PERRIER) the dorsal vessel extends as far forward as the brain; there it bifurcates and joins the branches formed by the bifurcation of the ventral vessel, thus forming 'a vascular collar in front of the nervous collar.' In these genera, in *Lumbricus*, and in fact in all the higher Oligochaeta the dorsal vessel gets to be very much less in calibre anteriorly and communicates indirectly with the ventral longitudinal trunks; in these Oligochaeta the vascular system as a whole is, as will be pointed out, excessively complicated as compared with the lower forms; the fact therefore that in the lower forms the dorsal and ventral vessels communicate directly by vascular arches similar to those which occur in succeeding segments is not to be looked upon as a difference of importance, but merely as a result of the more highly-developed vascular system of the former. In the Tubificidae, for example, there is in the first segment of the body a vascular arch connecting the dorsal and the ventral vessels directly and quite similar to the following arches which put these vessels into communication in ensuing segments; but these facts will be fully gone into in a subsequent section. Posteriorly the dorsal vessel appears gradually to fade away in some worms; in others, as in *Megascolex*, for example, it terminates abruptly just after giving off the last pair of dorso-tegumentary trunks.

A remarkable condition of the dorsal vessel was first described by myself in *Megascolex coeruleus*; in this worm the anterior part of the tube is partially divided into two halves which reunite at the septa; a large number of earthworms are now known which exhibit this peculiarity. It is, moreover, not a question of systematic position; the most diverse families show this condition; it has been found, for example, in *Octochaetus multiporus, Acanthodrilus novae-zelandiae, Microchaeta rappi, Teleudrilus ragazzii*, etc. Three degrees of the division of the dorsal vessel exist; in *Megascolex*, for instance, the vessel is only double in the anterior part of the body; in other types the dorsal vessel is double from end to end of the body; here again there is a difference; in *Octochaetus multiporus* and in *Acanthodrilus annectens* the vessel is completely double; there are two distinctly separate tubes running side by side on the dorsal surface of the gut; in *Acanthodrilus novae-zelandiae* there are two such tubes in the middle region of each segment, but at the septa the two tubes fuse. The interest attaching to these facts lies mainly in that they seem to

indicate the persistence of an embryonic condition; for VEJDOVSKY showed that in *Criodrilus* the dorsal vessel was developed from two independent tubes, and he has recently extended this discovery to species of *Lumbricus* (s. l.). As a general rule the dorsal vessel of the Oligochaeta is of much the same diameter throughout; but in a few forms it is locally dilated; this is the case, for instance, with *Microchaeta* where there is heart-like swelling in the ninth segment. In various Enchytraeids too there is a dilatation of the dorsal vessel just where it arises from the peri-intestinal sinus.

Fig. 16.



BOTHRIONEURON VASCULAR SYSTEM.

(After Stolc.)

I–IX. Segments. 1–6. Lateral hearts. 7. Ventral vessel. 8. Pharynx. 9–14. Vessels supplying intestinal network. 15. Sub-intestinal vessel. 16–19. Vessels supplying intestinal network. 18, 21. Intestinal hearts. 22. Supra intestinal vessel. 23. Dorsal vessel.

The Supra-intestinal vessel.—In addition to the dorsal vessel a good many Oligochaeta possess another vessel, also running along the dorsal side of the gut, which has been termed the 'Supra-intestinal' vessel. It is not long since the presence or absence of this vessel would have been held to be at least partly distinctive of the two groups instituted by CLAPARÈDE, the 'Limicolae' and the 'Terricolae.' Until the researches of STOLC the supra-intestinal vessel was considered to be confined to the Terricolae, although not occurring in all the genera of that group. It is, however, now known to exist in a number of Tubificidae as well as in the aberrant genus *Phreodrilus*. The supra-intestinal trunk is limited to the oesophageal region, where it takes the part with reference to the intestinal circulation that is elsewhere played by the dorsal vessel. In the oesophageal part of the alimentary canal the dorsal vessel comes to be some way removed from the gut, and it gives rise to a series of stout lateral branches which embrace the gut and join the ventral vessel without being connected in any way with the walls of the gut.

It has been stated that the supra-intestinal trunk passes back along the intestine as the typhlosolar trunk; but this appears to be very doubtful; the careful researches of BOURNE (**4**) into the circulation of *Megascolex coeruleus* do not support the existence of such a vessel; and, considering its relations to the gut and to the body-wall in the oesophageal segments, it does not seem likely on *a priori* grounds that it does exist in the intestinal region, where indeed it would seem to be *de trop*.

This blood-vessel resembles the dorsal vessel in being also directly connected with the ventral vessel; among the Tubificidae such connexions occur, and in *Branchiura* there is a pair of hearts of this description coexisting in the same segment with a pair of hearts arising from the dorsal vessel; in the earthworms it is frequently the case, as I mention more in detail further on, that the same pair of hearts arise both from the supra-intestinal and the dorsal vessel. Another point in which this vessel resembles the dorsal is that it is occasionally double; in *Megascolex coeruleus* this is the case, as has been described by both BOURNE and myself. The supra-intestinal vessel is by no means present in all of the higher Oligochaeta; it is present in most of the genera belonging to the two families Megascolicidae and Eudrilidae. It may perhaps be a question to which of the two dorsally-placed trunks the single vessel of, for example, the Naidomorpha corresponds. I have suggested that the intimate relations of the supra-intestinal to the alimentary canal indicate that the posterior part of the dorsal vessel is its homologue and that the anterior part of the dorsal vessel is a new structure in the higher Oligochaeta—the relations between the two being somewhat analogous to those which subsist between the vena cava posterior and the posterior cardinals in the Vertebrata. This view seems to be supported by the relations obtaining in the genus *Phreodrilus*. In that worm there are in the anterior region of the body two trunks upon the dorsal side of the alimentary tract which I homologize respectively with the dorsal and supra-intestinal of other Oligochaeta. These two vessels can be distinguished, not only by their position but also by their minute structure; the vessel which is closest to the wall of the gut, lying in fact upon it, has thin walls and is full of blood after death; the other has thicker walls and is not so full of blood after death; moreover the latter has not the coating of chloragogen cells which occur in the former; it is coated with flattened cells without pigment; this vessel, which I believe is the dorsal vessel of the higher Oligochaeta, terminates at about the fifteenth segment; behind this point there is only the supra-intestinal. The question, therefore, arises whether the vessel, which I have termed dorsal, is really the equivalent of the similarly named vessel in the Naids, etc.

The Ventral vessel.—This vessel is present along the whole body in all Oligochaeta. It is invariably a single tube never showing any signs of duplication as does the dorsal vessel. The ventral vessel also differs from the dorsal vessel in that it is never contractile[1]. Another fact of importance is that it is the first blood-vessel to be developed; this is at any rate the case with *Rhynchelmis* and *Lumbricus* (several species) in which alone the origin of the vessel has been carefully studied. The ventral

[1] *Phreoryctes* is said to be an exception to the statement.

vessel in its earliest stage is simply a slight thickening of the splanchnopleure; for some time it remains solid and only subsequently becomes hollow. In the view of some writers, for example WILSON, the ventral vessel is from the first hollow and its cavity is the remains of the segmentation cavity.

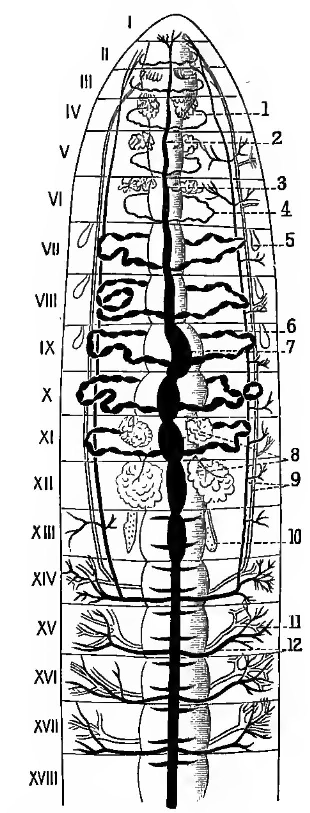
In many of the lower Oligochaeta the ventral vessel terminates in front by bifurcating and ultimately joining the dorsal vessel by a loop round the gullet; in *Chaetogaster* however it ends in a solid cellular cord which bends upward and ends freely in the neighbourhood of the cerebral ganglia. In the higher Oligochaeta the ventral vessel branches anteriorly and communicates with the dorsal vessel only through a capillary system. In two Tubificidae the ventral vessel terminates anteriorly in an altogether peculiar fashion. In *Lophochaeta* the ventral vessel appears to end in the eighth segment in a pair of hearts which communicate with the supra-intestinal trunk; but from the angle formed by the bifurcation an extremely slender vessel passes forward and after receiving three branches from the sub-intestinal vessel joins that vessel in the seventh segment; the single vessel formed by the fusion of the two terminates anteriorly in the usual way. In *Bothrioneuron* the narrow continuation of the ventral vessel commences in segment vii., and without receiving any branches from the sub-intestinal joins it in segment vi. These facts were described and figured by STOLC (**3**), whose figures are here reproduced (woodcuts, figs. 16, 18).

The Sub-intestinal vessel.—I apply this term to the usually paired vessels called by PERRIER and BOURNE 'Intestino-tegumentary' vessels, and by BENHAM 'lateral longitudinal' vessels. They are first seen in the family Tubificidae; in *Lophochaeta* and in *Bothrioneuron* where their relation to the ventral vessel has already been referred to. In *Lophochaeta* the ventral vessel divides in the seventh segment into two trunks, one lying above the other; the uppermost of the two is closely applied to the ventral wall of the alimentary canal and appears to be intimately concerned with its blood supply; it has much the same relations to it below that the supra-intestinal vessel has above; the same vessel occurs in *Bothrioneuron*, but it begins earlier, in the sixth segment. In the higher Oligochaeta this vessel, or at any rate the vessel which I regard as its equivalent, is invariably double—with the possible exception of the Lumbricidae; HOWES in his 'Biological Atlas' has figured in that worm a single sub-intestinal vessel which JACKSON ('Forms of Animal Life') considers to be non-existent, but to have been mistaken for the impression of the attachment of the mesentery. In many other earthworms there are a pair of these vessels which arise from the intestinal plexus [1] and run for a short distance closely attached to the

[1] In *Benhamia schlegelii* HORST figures and describes these vessels as originating from the dorsal trunk just in front of the antepenultimate pair of hearts.

ventral surface of the gut; later however they leave the walls of the intestine and run freely suspended in the body cavity; they end anteriorly in a network of capillaries. These vessels occur in *Megascolex* (BOURNE), *Pontoscolex* (PERRIER) (woodcuts, figs. 20, 21), *Eudrilus* (BEDDARD), and other forms. In *Eudrilus* the sub-intestinal vessel is partly double and partly single like the dorsal vessel of other earthworms; it bifurcates in the neighbourhood of the calciferous pouches and is single between them. In another Eudrilid, *Libyodrilus*, I have traced the course of these vessels for a little distance; they are double all the way and give off two pairs of branches in each of the segments through which I followed them; one pair of branches go to the septum, the other to a muscle suspending the intestine; numerous minute twigs connect them with the intestinal plexus. In *Megascolex coeruleus* the vessel in question only extends back to the thirteenth segment; after this there is a small vessel in each segment running from intestine to septum which is its equivalent.

Fig. 17.



SPARGANOPHILUS. GENERAL ANATOMY.

(After Benham.)

1, 4, 6. Perivisceral vessels. 2, 3, 7. Dorsal vessel. 5. Spermatheca. 8. Sperm-sacs. 9. Intestino-tegumentary vessels. 10. Ovary. 11, 12. Dorso- and ventro-tegumentary trunks.

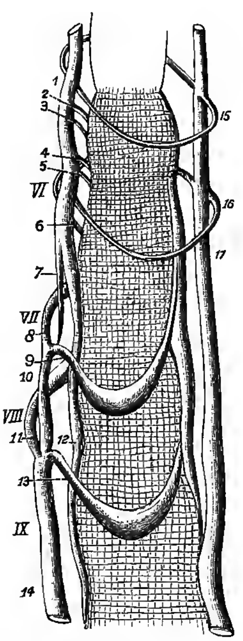
The Sub-nervian vessel. This is absent in the lower Oligochaeta and is by no means always present in the earthworms. It exists in *Lumbricus*, *Perichaeta*, and some other genera, and lies, as its name implies, beneath the nerve cord; it is even sometimes partially imbedded in the ventral body-wall. The presence or absence of this vessel served CLAPARÈDE with one of his characters for separating the Limicolae from the Terricolae.

§ 3. *Commissural vessels.*

The dorsal vessel in all Oligochaeta is connected with the ventral vessel by circular trunks which run round the alimentary canal. The simplest and most primitive arrangement of the vessels appears to be that which characterises the families Tubificidae, Phreoryctidae, and Lumbriculidae. In these worms there are at least one pair of such vessels in each segment of the body—the regular metamerism of the vascular system being thus very apparent. In the anterior region of the body one or more of the commissural vessels are specialized and become contractile, being then usually termed

'hearts.' In *Tubifex rivulorum*, for example, the commissural vessels of segment viii are greatly dilated and contractile. In *Limnodrilus* and *Clitelli* there are two such contractile circles, but they are not always larger than the unmodified perivisceral trunks. In other Tubificids a larger number of the anterior perivisceral are modified into contractile hearts. Further details will be found under description of Tubificidae. In the Naidomorpha the direct connexions of the dorsal and ventral vessels only exist in a few of the anterior segments; this also is the case with the Enchytraeidae and the Aphaneura. The smallest number of commissural vessels occurs in *Pristina equiseta*, where BOURNE only found one. The fact that in the newly-formed bud of *Uncinais littoralis* there are commissural vessels in all the segments, most of which become afterwards lost, is an indication that the disappearance of all but the few anterior commissural vessels in the Naidomorpha and Enchytraeidae is due rather to degeneration than to the retention of any primitive character. In some Tubificids there is another class of commissural vessel in the anterior segments of the body; one or more of the hearts instead of forming the *dorsal* and the ventral vessels unite the *supra-intestinal* with the ventral. The name 'intestinal hearts,' introduced by PERRIER for the corresponding structures in earthworms, may be applied to these. It is difficult to determine whether or not these trunks are serially homologous with the remaining hearts and with the peri-intestinal vessels of the segments in the posterior region of the body.

Fig. 18.



LOPHOCHAETA. VASCULAR SYSTEM OF SOME OF THE ANTERIOR SEGMENTS.
(After Stolc.)

1. Ventral vessel. 2–6. Vessels joining intestinal network. 7. Slender posterior part of ventral vessel just after it joins. 12. Sub-intestinal vessel. 9, 13. Intestinal hearts. 15, 16. Commissural vessels. 17. Dorsal vessel.

In *Bothrioneuron*, *Lophochaeta*, and *Phreodrilus*, the intestinal hearts occur in segments posterior to those which contain the dorsal hearts; but in *Branchiura* the eighth segment contains two perivisceral vessels, of which one seems to be the equivalent of the intestinal, the other of the dorsal heart.

In the higher Oligochaeta the intestinal hearts are connected in many cases with both of the dorsally running blood-vessels; so that one connection may be regarded as secondary. In these Oligochaeta, in the earthworms in fact, the commissural vessels are confined to the anterior segments of the body; but this specialization is not due, as it may be in the Naidomorpha, to degeneration;

it appears to be due to the fact that the commissural vessels of the posterior segments have given rise to the integumental blood-plexus, and have become largely lost in the process; there are, as I shall point out later, the beginnings of this plexus to be seen in the Tubificidae; it attains to its highest development in the Oligochaeta terricola; but in the embryo *Lumbricus*, as Vejdovsky has shown (see woodcut, fig. 19), each segment has a pair of commissural vessels. The number and position of the hearts in the earthworms varies very considerably; it is rare, however, to find them extending behind the thirteenth segment. As a rule the last three or four, often two of these, are connected either with both the dorsal and supra-intestinal vessels or with the latter alone; this kind of connexion, however, does not occur in the Lumbricidae, and apparently not in the Geoscolicidae; it occurs only in the Megascolicidae and the Eudrilidae among the Megadrili; the Moniligastridae agree in this character with the Geoscolicidae and the Lumbricidae. As a rule the intestinal hearts are much more dilated than the others, and they show in a more pronounced fashion the moniliform character which these organs often exhibit; this is really due to the presence of valves along the course of the commissural vessels, which allow the blood to flow in one direction only.

§ 4. *Peripheral circulation.*

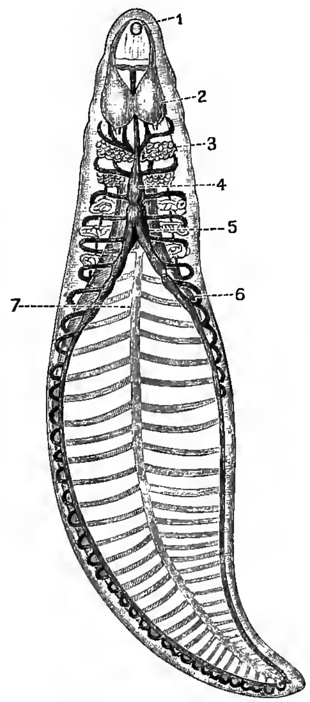
In addition to the longitudinal trunks and to the commissural vessels which unite them, there is in all Oligochaeta a system of smaller vessels, which form plexuses and may be termed capillaries; it is convenient to divide these capillary networks into two series, the integumental and the intestinal. The former includes all the capillaries which ramify in the thickness of the body-wall, the septa, and in fact all the organs of the body except the alimentary system; the reasonableness of making this apparently artificial division is shown by the fact that in the lowest Oligochaeta there is no capillary system except that which supplies the intestinal walls, and that the two systems are quite distinct, being only indirectly connected in the higher forms. In the Aphaneura, the Enchytraeidae, and the Naidomorpha, the intestinal system of capillaries is the only one that is present. In the two former groups the dorsal vessel loses itself in this plexus; it seems a little doubtful whether in the adults of any of these worms there really exists, as has been described, a blood-holding space surrounding the gut; when the capillaries are gorged with blood, there would naturally be a tendency to the obliteration of the boundaries of the meshes of the network which would of course produce the impression of a continuous sinus. As to *Aeolosoma*, however, the figures of Vejdovsky show plainly that there is a plexus and not a sinus; in the Enchytraeidae

a sinus has been generally asserted to exist; but MICHAELSEN figures in *Stercutus*, for example, appearances which are much more in accord with the assumption that there is really a network: he speaks, however, in this case of a 'Darmblutsinus.' The same word is used in his revision of the family, and therefore containing his latest opinions on the matter, with which also VEJDOVSKY agrees. The existence of this sinus, if real, is of interest in connexion with the perienteric sinus in certain Chaetopods (for example *Fabricia*); the fact that in *Aeolosoma* and the Enchytraeidae the dorsal vessel arises from this sinus becomes additionally interesting from SALENSKY'S discovery that in *Terebella*, etc., the embryo has a dorsal vessel similarly connected with, indeed arising from, a perienteric blood-sinus. As to the Oligochaeta, embryology does not seem to indicate that this sinus is primitive; in *Rhynchelmis* VEJDOVSKY describes the dorsal vessel as arising from the perienteric *plexus* (not sinus). It will be noted, however, that the limited extent of the dorsal vessel and its origin out of the perienteric vessels is an embryonic character in the Aphaneura and Enchytraeidae. Whatever may be the case with the lowest Oligochaeta, it is certain that in the Naidomorpha and in all the groups above them, there is not a plexus but a network of capillaries in the intestinal walls; this has been figured by STOLC and others in the Naidomorpha, and by the same and also by others in the Tubificidae; in these worms the network is fed from the dorsal vessel, and the blood returns into the ventral vessel; the network at any rate has connections with both vessels. Among earthworms *Sparganophilus* has been said to possess a sinus by BENHAM; I confess to being unwilling to accept this statement, for the reasons already stated, i.e. the difficulty of proving that the supposed sinus is not really a plexus with largely obliterated boundaries. The intestinal network of the higher Oligochaeta is described below in the genus *Megascolex*, in which it has been carefully studied by BOURNE.

The integumental blood plexus shows a gradual increase in complexity as we pass from the higher to the lower forms. It is, as already stated, entirely absent in the Enchytraeidae and the Aphaneura. The first traces are to be found in *Limnodrilus*, where the lateral commissural vessels give off (in *Limnodrilus hoffmeisteri* at any rate) a bunch of small vessels which seem to end caecally in the skin. In other Tubificidae the integumental system is much more developed; in *Ilyodrilus*, for example, where the circulation has been carefully studied by STOLC, there is a complex network in the integument; it appears from his figures (the text being in the Bohemian language is inaccessible to me) that in each segment of the body behind the first a special pair of vessels is given off from the dorsal vessel which supply the plexus, and that branches of the commissural vessels receive the blood from

the plexus and convey it to the ventral vessel. The integrity of the commissural vessels is, however, preserved; in the higher Oligochaeta the integrity of these vessels is lost (except in the embryo, see woodcut); they become largely dissolved into the network of capillaries. In the lower Oligochaeta it is only the actual body-wall which sometimes possesses a capillary network, none of the other organs of the body (as a general rule) have such; the sperm-sacs, for instance, are fed by specially elongated perienteric loops belonging to the segments in which they occur. The nephridia in *Rhynchelmis* are peculiar among the lower Oligochaeta, in that they have similar loops attached to them and following their windings; and in *Tubifex* NASSE has described vessels in the nerve-cord. With these exceptions there is no peripheral vascular system other than the integumental network until we reach the true earthworms; and here it is not always at the same pitch of development; in the smaller forms, such as *Ocnerodrilus* the nephridia seem to be quite unprovided with vascular networks.

Fig. 19.



EMBRYO LUMBRICUS.

(After Vejdovsky.)

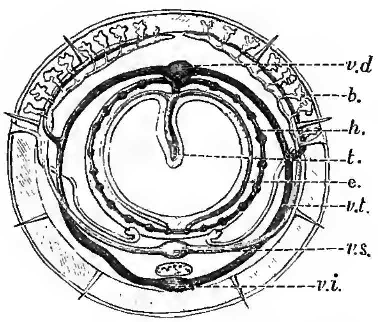
1. Aperture of 'head kidney.' 2. Brain. 3. Septal glands. 4, 5. Dorsal vessel. 6. Intestine. 7. Ventral vessel.

Epidermal capillaries.—It has been known for a long time that in the clitellar region the terminal branches of the vascular system push their way in among the cells, forming loops, which, however, stop short some little way below the surface. These capillaries are figured by CLAPARÈDE and by others. As to the vascularity of the rest of the epidermis, it was, I believe, first pointed out by myself that this was the case with *Megascolex coeruleus* (**2**) and some species of *Perichaeta* (**3**). The extension of blood-capillaries into the epidermis of *Criodrilus* has been figured by ROSA (**12**), and quite recently it has been discovered by LENHOSSEK (**1**) that the epidermis of *Lumbricus*—not only the clitellum—is also vascular. Even among the more delicate aquatic species this condition, very likely universal in the earthworms, is not unknown. *Limnodrilus* is furnished with apparently caecal vessels, which terminate between the epidermic cells. It has been stated by the SARASINS that in *Perichaeta* the capillaries actually reach the exterior, and open there; but this appears on the face of it to be unlikely, and at any rate needs further proof. The statement was made incidentally in connexion with an alleged similar opening of blood-capillaries on to

the exterior in the Gymnophionae. The physiological meaning of 'intra-epithelial blood-capillaries,' as LANKESTER has termed these structures in the leech, where he was the first to discover their existence, seems to be clear. One of the characteristics of the Oligochaeta is the rare occurrence of branchiae; *Dero*, *Chaetobranchus*, *Branchiura*, *Hesperodrilus branchiatus* and the questionable *Alma* are the only real (or reputed) Oligochaeta which form branchiae. The absence of these special organs is compensated for by the utilization of the entire skin as a branchial organ. The efficiency of the skin as a branchial organ must be largely increased by the penetration of the capillaries into the outermost layers.

BOURNE was led by his researches into the vascular system of *Megascolex coeruleus* to a reasonable view of the course of the blood in that species which will probably, as he thinks, prove to be more widely characteristic.

Fig. 20.



PONTOSCOLEX. TRANSVERSE SECTION TO SHOW BLOOD-SYSTEM.

(After Perrier.)

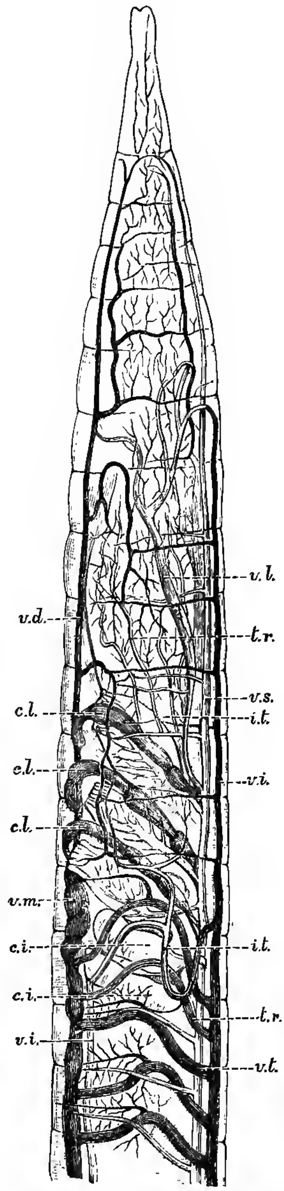
v. d. Dorsal vessel. *v. s.* Ventral. *v. i.* Sub-neural vessel. *h.* Intestinal plexus. *v. t.*, *b.* Tegumental system of vessels. *t.* Typhlosole.

Excepting at the head end of the body, where the vascular system like other organs shows a cephalization, it is metamerically arranged. Moreover the fact that an earthworm can live after a considerable part of its body has been shorn away indicates that each segment is to some extent independent in its circulatory mechanism.

There is no doubt—all observers agree upon that point, which can be easily seen in the living worm—that the blood flows forwards in the dorsal vessel. In the cephalized region of the body the blood passes down into the hearts; these contract from above downwards, just as the dorsal vessel contracts from behind forwards. In the intestinal region of the worm there are two sets of vessels connected with the dorsal vessel—the dorso-integumentary and the dorso-intestinal. It appears that blood flows from the latter into the dorsal vessel, and out of the dorsal vessel into the former. This view is not that universally accepted. In the anterior region of the body of course, the supra-intestinal vessel is supplied from the same source as is the dorsal vessel posteriorly. The ventral vessel of *Megascolex* communicates with the dorsal vessel anteriorly and directly by the hearts; posteriorly it communicates with the same tube, indirectly by the ventro-tegumentary vessels. According to BOURNE blood reaches the ventral vessel by the hearts; of the truth of this there can be hardly any doubt; he considers, however, that the ventro-integumentary vessels take

blood *away from* the ventral vessel to the parietes. There are thus two sets of vessels which convey blood to the integument—the dorso-integumentary and the ventro-integumentary. From the integument a series of intestino-integumentary vessels again returns the blood to the intestinal network, whence, as before stated, it reaches the dorsal vessel.

Fig. 21.



PONTOSCOLEX. CHIEF TRUNKS OF VASCULAR SYSTEM.
(After Perrier.)

v. d., *v. m.* Dorsal vessel. *c. l.* Contractile heart. *c. i.* Intestinal heart. *v. i* Supra-intestinal vessel. *v. l.* Lateral vessel. *v. s.* Ventral vessel. *v. t.* Peri-intestinal vessel. *t. r.*, *i. t.* Smaller branches of ventral vessel.

VII. Blood-Glands.

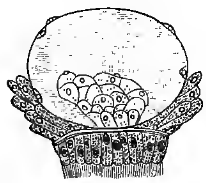
Connected with the vascular system there are in several Oligochaeta structures which seem to be of a glandular nature. Such structures occur in the Enchytraeidae, the Lumbriculidae, the genus *Phreodrilus*, the Perichaetidae, and perhaps the Eudrilidae.

It will be convenient to commence with a description of these various organs in the groups mentioned, before discussing the morphology and the functions which they may perform.

In the Enchytraeidae the dorsal vessel sometimes contains a cellular rod which has been named the 'Herzkörper' by Michaelsen (woodcut, fig. 22). It was described first in the genus *Mesenchytraeus* (Michaelsen), where it consists of a solid rod of cells attached to the ventral side of the dorsal blood-vessel, and extending along its whole length; 'in *M. mirabilis* and *M. primaevus* it is thick with irregular, often strong swellings multicellular in section. In *M. falciformis*, *M. beumeri*, and *M. flavidus*, it is thinner, quite smooth, with only feeble swellings, and in section shows only a few cells.' The organ is figured by Michaelsen. In a later paper the same organ was described in *Stercutus*. It has been justly compared by him to the cardiac body of certain Polychaetes, such as *Pectinaria belgica*, and a few others. As to its function it was suggested by Michaelsen that it served to ease the contractions of the dorsal vessel; he pointed

out that the flow of the blood forwards would be facilitated if the tube were completely closed posteriorly during contraction; the presence of this cardiac body would help to fill up the tube, and allow the lumen to be entirely obliterated without reaching the maximum degree of contractility of the dorsal blood-vessel.

Fig. 22.



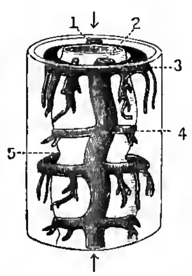
HEART BODY OF ENCHYTRAEID.

(After Michaelsen.)

The genus *Lumbriculus* and other Lumbriculidae have a series of caecal diverticula (woodcut, fig. 23) of the dorsal vessel, which are clothed with large chloragogen cells, and are contractile; these were formerly mistaken for caeca of the gut itself, but there is no doubt that this was an error; they serve as temporary reservoirs of the blood, which is presumably subjected during its sojourn in them to the action of the peritoneal cells which envelop them. Nothing of the kind exists in any worm that is not a Lumbriculid, though they are not found in the Lumbriculid genus *Stylodrilus*.

A third kind of blood glands (woodcut, fig. 24) are to be met with in various species of the genus *Perichaeta*. They were originally described by Perrier (**3**), who thought them to be of the nature of salivary glands; they occur in *Perichaeta houlleti*, for example, at the sides of the oesophagus and show a distinctly metameric arrangement, being grouped in accordance with the segments. These glands consist of a number of spherical acini, which have a solid appearance, and are composed of small rounded cells; they have, however, as I (**43**) showed, no connexion whatever with the gut, and are simply dilatations upon the blood-vessels comparable to those dilatations which occur along the course of the nephridial tubes, than which, however, they are considerably larger; a blood-vessel can be traced into them and out of them. They are covered externally by masses of pigment-holding peritoneal cells, and form with these fairly compact glandular masses. Something of the same kind appears to exist in at any rate one species of *Acanthodrilus*, *A. rosae*.

Fig. 23.



LUMBRICULUS: BLOOD GLANDS.

(After Claparède.)

1. Ventral blood-vessel. 2. Dorsal blood-vessel. 3–5. Branches of last with caecal twigs.

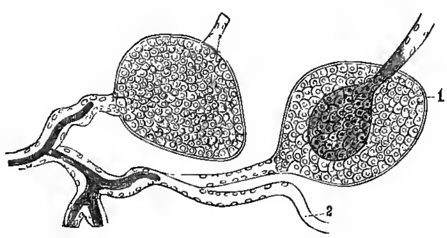
In the aquatic Oligochaet genus *Phreodrilus* another variety of organ of possibly a similar physiological nature occurs; in the twelfth and thirteenth segments of this worm is a coiled tube which puts the dorsal and the ventral vessel into communication; it is so much coiled that I have not been able to ascertain its exact shape; the interior of this vessel, which

is perhaps the homologue of the perienteric vessel of its segment, is largely filled by a mass of big vesicular cells containing granules. They are so numerous as to nearly occlude the lumen of the blood-vessel.

The last variety of these organs are possibly the modified calciferous glands of certain genera of Eudrilidae, for instance *Stuhlmannia*. I have, however, described these in full under the description of the calciferous glands, and need not recur to the matter here.

The nature of these various glands now requires consideration. There can, I think, be no morphological comparison between the organs in *Perichaeta* and those of the Lumbriculidae, on the one hand, with the other varieties of blood-glands; nor is there any relation except perhaps a physiological one between the blood-glands of the two genera of worms mentioned; the other organs do appear to me to be probably morphologically connected. There is no doubt, I imagine, that the peculiar glands of certain Eudrilidae which I have described above are really the equivalents of the calciferous glands; their lumen, although much reduced, communicates with that of the oesophagus; and the segments which they occupy are those in which calciferous glands, when present, commonly lie. At the same time it appears to be at least probable that their function is a different one from that possessed by the calciferous glands; I could find no evidence of a secretion of calcareous particles; this merely negative evidence is not perhaps very strong, since I have often failed to discover any such particles in the lumina of glands which are undoubtedly calciferous glands. It is the structure which leads to the inference that the glands now under consideration are not functionally calciferous glands; this is most clearly marked in *Eudriloides*, and the structure in that genus offers a clue to what is the real function of the glands in question. The peculiar cells which make up the mass of the glands become altered in *Eudriloides* towards the periphery of the glands; it gets to have a distinctly columnar arrangement; but the columns of cells are disposed round a lumen which is filled with blood and which is a blood-vessel traceable into connexion with the other blood-vessels of the gland and the surrounding organs; the structure seems to be irreconcileable with any other theory than that the glands in question have some secreting function in relation to the blood or eliminate effete matters from the blood; we have in fact a gland originally performing a function connected

Fig. 24.



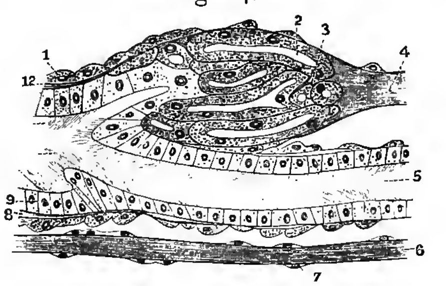
PERICHAETA: BLOOD GLANDS.

1. Dilatation upon blood-vessel filled with corpuscles.
2. Small blood-vessel.

with alimentation converted into a quite different physiological path, and one which must bear some relation to the vascular system.

Now there is some evidence that the 'cardiac body' of certain Enchytraeidae has had a similar origin. In *Buchholzia* the paired dorsal diverticula of the oesophagus, which are comparable probably to the calciferous glands of earthworms, are surrounded by a blood-sinus where they are attached to the gut; this blood-sinus becomes further forward the dorsal vessel; there is thus a diverticulum of the oesophagus, as it were thrust into the dorsal vessel; it is to be pointed out in the first place that a dorsal diverticulum of the gut never coincides with a cardiac body; Horst was apparently the first who compared the cardiac body of the Chlorhaemidae with the gut diverticulum of the Enchytraeidae; it is not in my opinion a valid objection to this identification to point out, as Cunningham has done[1], the absence of any present connexion between the cardiac body and the epithelium of the oesophagus; such a communication may easily have become lost; there are plenty of analogous instances. If we imagine the gut-diverticulum to lose its lumen a cardiac body is at once produced. We should therefore look upon those forms which have a cardiac body as being more modified than those in which there is a gut-diverticulum; as in the genus *Aeolosoma* there is a trace at least of a cardiac body, better marked in the perhaps allied *Ctenodrilus;* these genera are perhaps to be regarded as the descendants of genera in which there was a dorsal diverticulum of the oesophagus—an argument for the non-primitive character of *Aeolosoma.* It seems to me to be also possible that the blood-glands of *Phreodrilus* are referable to the same characteristic diverticula of the oesophagus. The cells contained in the lateral vessels will be on this interpretation the remains of the calciferous glands; the vessel which contains them will be the hypertrophied vessel originally supplying these hypothetical glands; this may also help us in understanding the anomalous presence of an intestinal heart in *Branchiura* in the same segment as that which also contains a dorsal heart; if the intestinal heart be regarded as the last trace of a vanished pair of calciferous glands the difficulty

Fig. 14.



BUCHHOLZIA. CALCIFEROUS GLAND.

(After Michaelsen.)

1. Peritoneal layer. 2, 3. Tubules of gland 4. Dorsal vessel. 5. Lumen of intestine. 6. Ventral vessel. 7. Peritoneum. 8, 9. Muscular and epithelial layers of intestine. 12. Vascular sinus of intestine.

[1] 'On some points in the Anatomy of Polychaeta,' Q. J. Micr. Sci. vol. xxviii, p. 259, etc.

of accounting for its existence vanishes also; but this is, of course, purely speculative.

There are various interesting analogies, if no more, between this series of glands in the Oligochaeta and certain structures in the Vertebrata. WELDON has traced the origin of the supra-renal body in the Marsipobranch *Bdellostoma* to a detached portion of the pronephros, and he has described and figured an originally secreting gland with blood in its lumina—a state of affairs closely paralleled by the condition which I have just described in *Eudriloides*. A closer resemblance still is offered by such glands as the thyroid and thymus; originally connected with the oesophagus, or with diverticula of the same, these glands become entirely detached from it, and have acquired some function in relation to the vascular system. It is also said that the spleen is developed as a diverticulum of the gut; if this be proved to be the case the analogy is so close that we are almost justified in an actual comparison of the blood-glands of these Oligochaeta with the vertebrate spleen. The spleen is permeated by blood-vessels just as are the glands in the Oligochaeta, and its origin as a diverticulum of the mesenteron leaves no resemblance unaccounted for. At the very least the analogy is interesting and I draw attention to the resemblances for what they may be worth.

VIII. RESPIRATORY ORGANS.

Dealing as this work does with a group of worms which were termed by CUVIER 'Annélides sétigères abranches,' and which are constantly distinguished by the absence of branchiae from the Polychaeta the present chapter might seem to be superfluous. Nevertheless *there are a few forms which possess special respiratory organs, and two in which these branchiae are much like those of certain Polychaeta.* In the great majority of Oligochaeta there are no special respiratory organs—the general body surface occupying the place of a lung or branchia[1]. Where the integument is thick there are always plexuses of blood capillaries in the integument, which bring the vascular system into close relations with the external medium and presumably allow of an exchange of gases. The blood, as has been already mentioned, is in all Oligochaeta, with the exception of *Aeolosoma*, *Chaetogaster*, and certain of the Enchytraeidae, tinged with Haemoglobin; we may fairly suppose that this substance plays the same part in respiration among these Annelids as in the Vertebrata. The efficiency of the skin as an organ of respiration in many Leeches is largely increased

[1] The nephridia were once regarded as respiratory organs and as the equivalents of the tracheae of insects. The dorsal pores also were considered to perform a similar function.

by the extension of the blood capillaries to the epidermis itself; this interesting fact was first discovered by LANKESTER. I myself extended this discovery (**3**) to Earthworms, and in the genera *Megascolex*, *Perichaeta*, *Criodrilus*, *Moniligaster*, &c., as I and others have shown, the epidermis of *the body in general*—not merely the clitellum—*is vascular*. As a general rule the lower Oligochaeta, in which the dermo-muscular tube, in correspondence with their small size, is actually—sometimes also relatively—thinner, than in the terrestrial worms, have no development of a capillary system in the skin. This rule, however, is not without exceptions. *Limnodrilus Hoffmeisteri* has tufts of blood capillaries which arise from the peri-intestinal trunks and enter the body wall, reaching even to the epidermis itself [VEJDOVSKY, **24**, Taf. viii, figs. 16, 17]. More highly developed still is the integumental vascular network of *Ilyodrilus* (STOLC **3**) and *Branchiura* (BEDDARD **58**). Many Tubificidae and Lumbriculidae, appear to respire chiefly at the posterior end of the body; they live in the mud at the bottom of ponds, ditches, &c., with the head implanted and the tail waving about in the water. Now in the worms which have this habit, and for the matter of that in others too, the body gradually diminishes in calibre and in the thickness of its walls towards the anus; hence the blood is necessarily brought into closer relation with the surrounding water. There is in these Oligochaeta, at least, a commencing localization of the respiratory function to the tail end, in accordance with the attenuation of the body in this region. And we find that when branchiae are developed they are in every instance but one confined to the caudal extremity.

For a long time the only Oligochaet known, which could be said to possess special respiratory organs was *Dero*. This genus of Naidae is remarkable for possessing at the end of the body an expanded hood formed by the widening out of the anus; from the inner surface of this arise two pairs of (usually) cylindrical processes. These processes, as well as the hood which covers them, are ciliated; they can only be moved by means of intrinsic muscular fibres. The principal descriptions and illustrations of this branchial area are those by PERRIER (**10**), and BOUSFIELD (**3**). In describing the organ I shall follow PERRIER'S description and illustrations of *Dero* '*obtusa*' (=really *D. perrieri*, Bousf.). The branchial processes themselves are covered with a ciliated epithelium and their cavities are largely occupied by spindle-shaped or stellate muscular fibres[1]. The vascular supply is derived from a direct continuation of the dorsal and ventral vessels. The ventral vessel passes undivided to about the middle of the hood; here it divides into two trunks which run round the margin of the hood and give off six branches—one to each of the branchial

[1] In *D. digitata* there are also retractor muscles for each branchia.

processes, and one on each side passing obliquely across the hood; they then bend upwards and become continuous with the dorsal vessel; each branchial capillary runs up the branchia to its tip and then bending upon itself runs down the opposite side of the branchiae; these and the other branches fuse together and form the dorsal blood-vessel.

In *Dero obtusa* the circulation in the branchiae is somewhat simpler; it was described and figured by D'UDEKEM (**1**). The ventral vessel divides as in *D. perrieri* but simply pursues a sinuous course, passing up and down each branchia; the right and left halves of the circle unite at the base of the branchial hood to form the dorsal vessel. *Dero digitata* has more complicated vascular loops than even *D. perrieri*. The arrangement of these has been worked out by STOLC (**2**). Each of the four branchial processes has two capillary loops instead of only one; and there are two circular vessels, derived from the ventral vessel, which form complete circles and do not communicate with the dorsal vessel except by the recurrent loops from the branchiae.

It seems clear from the habits of the worm and from the structure of these circumanal processes that they must be regarded as branchiae; the expanded hood which is itself in some species furnished with elongated processes is no doubt also branchial in function. The next Oligochaet, in order of discovery, which is branchiate, is *Alma nilotica*. In the systematic part of this work I discuss whether this form (recently re-described by LEVINSEN as *Digitibranchus niloticus*) be really an Oligochaet. The conclusion arrived at is that it is an Oligochaet. The branchiae, like those of *Dero*, are found at the posterior end of the body. It is very desirable that this form should be re-investigated, for at present there are no details concerning the structure of the supposed branchiae to hand. There is, however, hardly room for doubt as to the branchial nature of the short cylindrical processes which are found upon the last sixty or seventy segments of the body. They occur just to the dorsal side of each dorsal pair of setae and there are four or five on each side, sometimes simple and sometimes branched. *Chaetobranchus semperi* is a remarkable branchiate Naid, apparently known to SEMPER, and lately described by BOURNE (**1**). I can confirm from personal observations BOURNE'S description of the branchial organs, which, unlike those of *Dero*, are confined to the *anterior* part of the body. The most anterior, after the first one or two pairs, are the longest; and in those anterior ones are imbedded the long capilliform setae of the worm; further back the setae are independent of the branchial processes. The inclusion of the setae within them is not unsuggestive of a comparison with parapodia of the Polychaeta. These branchia in *Chaetobranchus* are ciliated externally, they contain a capillary loop

which runs in the axial cavity of the branchiae; the walls are cellular and have no muscular fibres.

In *Branchiura* the branchiae are not lateral in position as in the last genus, but dorsal and ventral. They contain a prolongation of the coelom, which, however, is shut off by a diaphragm from the general coelomic cavity. The branchiae are contractile owing to the presence of a layer of muscular fibres lying immediately beneath the epidermis; the latter is not ciliated. Immediately beneath the epidermis is a blood-vessel on either side. The branchiae are limited to the posterior region of the body. The reason for this is probably that this Tubificid, like others, rests with its head imbedded in the mud and its tail waving freely in the water. The last branchiate Oligochaet is also a Tubificid, *Hesperodrilus branchiatus*, in which the branchiae are like those of *Branchiura*, but lateral instead of dorsal and ventral.

IX. Reproductive System[1].

The Oligochaeta like some other animals which are hermaphrodite possess a complicated series of organs related to the reproductive function. We can distinguish the essential organs, and those which are unessential and only concerned with impregnation or the liberation of the genital products. The essential organs are of course the ovaries and testes—the gonads; these are the first part of the reproductive system to make their appearance in the embryo. Then there are the ducts which convey the sexual products to the exterior, the sperm-ducts and oviducts, and the sperm-sacs and egg-sacs where the sexual elements undergo development; finally we have a series of organs which are concerned in the mutual impregnation of the worms; the glands and sometimes penial setae appended to the sperm-ducts, the spermathecae for the reception of the sperm during copulation, etc. The various organs essential and non-essential have fixed positions in the body of the worm; one organ is found always in one segment, another in a second segment, in every species, the positions being characteristic for the species or the genus or family as the case may be. The table appended illustrates the varying position of the parts of the reproductive system in all the families of aquatic Oligochaeta and a few earthworms. The reproductive organs are segmentally arranged just as are most of the other organs of the body; but, as also is the case with other organs, the metameric arrangement is sometimes lost or obscured; the sperm-ducts for instance are not always confined to a segment nor are they framed of a series of metamerically

[1] For asexual reproduction, see under *Aeolosoma* and Naids.

arranged parts. The sperm-sacs, too, though often ranged with an absolute regularity, sometimes show the same kind of divergence from what we must consider to be the normal for a segmented worm.

Plates I and II represent the genitalia of various Oligochaeta depicted diagrammatically.

	SPERMATHECA.	CLITELLUM.	TESTES	OVARIES.	♂ PORE.	OVIDUCAL PORES.
Aeolosoma . .	3; 3 & 4; 4 & 5 or 3, 4, 5	5-6	v	vi	absent	6
Enchytraeidae . or in	5	11-13	xi	xii	12	13
Buchholzia .	5	8, 9	vii	viii	8	? 9
Naidomorpha	5	5-7	v	vi	6	6/7
Phreodrilus .	13	12-15	x, xi	xii	12	12/13
Tubificidae . .	10	10, 11	x	xi	11	11/12
Trichodrilus . .	11, 12		x	xi	10	11/12
Claparedilla . } *Stylodrilus* . }	9		x	xi	10	11/12
Phreatothrix . .	11, 12		x	xii	10	11/12
Rhynchelmis . .	8		ix, x	xi	10	11/12
Lumbriculus . .	10, 11, 12				8	10, 11
Eclipidrilus .	9				10	10/11
Sutroa	8	7-15	ix, x	x	10	11/12
Phreoryctes . .	7, 8	10-13	x, xi	xii, xiii	11, 12	12/13, 13/14
Pelodrilus . .	8	11-13	x, xi	xii	12, 12	12/13
Perichaeta .	5 (7)-8 (9)	14-16	x, xi	xiii	18	14
Megascolex . .	5 (6, 7)-8/9	13 (14)-17	x, xi	xiii	18	14
Acanthodrilus .	(7) 8, 9	13-17 (19)	x, xi	xiii	18	14

§ 1. *Gonads.*

The gonads are developed from the peritoneal epithelium and are nearly always paired structures, probably they are really paired in origin in such forms as *Aeolosoma* where they appear to be single. Both male and female gonads are present in all Oligochaeta; there is no instance known of an unisexual form. The *ovaries* are most usually a single pair but there are sometimes an additional pair; no more than two pairs of ovaries have ever been certainly made out[1]. The ovaries invariably agree in position with the testes, but they are of course situated in different segments;

[1] Except in abnormal specimens such as those described by WOODWARD (1, 2).

they furthermore agree so closely with the testes that in the early stages it is impossible to distinguish the two kinds of gonads save only by the segment which they happen to occupy. Not only is there this close agreement in structure (in the immature condition) and in situation, but the shape of both gonads is at first identical; the immature ovary like the immature testis is somewhat pear-shaped in outline, the broader end being attached to the septum; later on the free end of the ovary, as is also the case with the testis, may become frayed out into a number of processes. The ovaries always lie behind the testes; the only possible exception is in the genus *Plutellus*, where PERRIER (**8**) has stated that the ovaries are in front of the testes; if, however, a worm described by BENHAM (**8**) as a *Plutellus* is really a member of this genus, there is nothing abnormal in the position of the female gonads. As a rule the gonads are all in consecutive segments, the ovaries following the testes, the rule indeed has very possibly no exception; this at first sight appears to be an inaccurate statement; for in *Lumbricus*, and indeed in all earthworms, the ovaries are in the thirteenth segment, while the last pair of testes, if there are two pairs, is in the eleventh segment; there is thus a gap of a segment between the last testis and the ovary of its side of the body. In embryos of *Lumbricus*, however, as was shown by WOODWARD, and in embryos of *Octochaetus*, as has been demonstrated by myself (**51**), there is an additional pair of ovaries in the twelfth segment, which never comes to maturity and disappears early. There are, therefore, some grounds for believing that two is the typical number of pairs of these gonads in the Lumbricidae and Acanthodrilidae, and very likely in other terrestrial forms also. The fact that there are two pairs of testes seems to render this assumption probable at least. In the genus *Phreoryctes* the number of ovaries (as of testes) is normally two pairs. Another fact pointing to the same conclusion is the presence in more than one species of *Perichaeta* of *two pairs* of egg-sacs; there is a pair in the fourteenth segment and another in many cases in the thirteenth segment; the latter would appear to correspond to a missing pair of ovaries belonging to the twelfth segment.

In fact both lines of argument appear to point to the primitive possession of two pairs of ovaries at any rate in the terrestrial Oligochaeta. The passage of ova from the gonad into the duct and still more into the egg-sac in the terrestrial Oligochaeta is not easy to understand; as to the former it must be remembered that in the living worm the distance is not great between the gonad and the large mouth of the funnel; it is possible that from time to time during the movements of the worm the distance is lessened; when this takes place the oviducal funnel may approach so near to the gonad that the movement of its cilia may perhaps detach a perfectly ripe ovum from the extremity of the ovary and direct its course into the funnel, and

thence either directly to the exterior or into the mouth of the egg-sac which lies conveniently near to the funnel. Among the Eudrilidae the passage of ova is enormously facilitated by the fact that the ovaries are enclosed in special peritoneal sacs which are continuous with the efferent duct; these sacs are late in their development, which seems to indicate their comparatively modern appearance; they were first discovered by myself in the genus *Eudrilus* (**62**); since that time they have been recognized in the majority of the Eudrilidae (which see for a more detailed description).

Ova.—The parasitic and encysted Gregarines were at one time mistaken for the ova of *Lumbricus*—perhaps not altogether an unnatural error. The ova are now known in a large number of Oligochaeta; but it is in *Rhynchelmis* that they have been most thoroughly studied (by VEJDOVSKY). It is a remarkable fact that the Oligochaeta can be divided into two groups according to the character of their ova; in the aquatic Oligochaeta the eggs are large and contain an abundance of yolk; in the terrestrial forms, on the other hand, the ova are of microscopic size and contain but little yolk. It is, it will be observed, the large forms which have small eggs and broadly speaking the small forms which have large ova. All the genera which were grouped by CLAPARÈDE within his group 'Limicolae' have large ova containing much yolk. Differences of size no doubt occur in both groups; but in no earthworm is the egg ever so large as it is in the aquatic worm with the smallest ova. The difference is a remarkable one; it is almost, if not quite, as striking as that between the ova of a Mammal (not of course Prototherian) and a Frog. The large size of the ova was justly made use of by D'UDEKEM in his classification of the Oligochaeta.

It is difficult to account for this striking difference; VEJDOVSKY (**24**) pointed out that there is a difference in the mode of nutrition in the ova in the two groups; in the aquatic Oligochaeta the eggs are early detached from the ovary and undergo further development in the body cavity or in egg-sacs; on the other hand, in earthworms the eggs reach maturity in the ovary which is furnished with abundant blood-vessels, which are wanting in the egg-sacs of the others; this latter statement is not quite accurate—at least in one way; it is perfectly true that there is no development of blood-capillaries on the egg-sacs of those worms; but special perivisceral vessels undergo an increase of length at the time that the egg-sacs are formed and accompany them. This cannot, however, be regarded as an explanation now; for in *Eudrilus*, and in the Eudrilidae generally, the eggs are apparently transferred at an early stage to the egg-sacs where they reach maturity; indeed, in some Eudrilidae the ovaries are even at an immature stage no longer to be found

in an ovary; they have been bodily transferred to the egg-sac. In *Libyodrilus* this appears to be the case; I succeeded in finding the ovaries in a very young worm, but not in mature or even in nearly mature specimens; no one has detected the ovary of *Polytoreutus*, though its position has been probably fixed with accuracy; in *Stuhlmannia*, too, the mass of cells described by MICHAELSEN as an ovary may be one, but it has none of the characteristic appearances of germinal tissue; I am of opinion that this is to be explained on the assumption that all, or nearly all, of the germinal cells have been made over to the egg-sacs.

The facts evidently require another explanation. It might be thought that there were differences in the development of the embryos sufficient to account for this. If, as one might perhaps infer from D'UDEKEM's figures, the eggs when large and full of yolk completely filled the cocoon to the exclusion of any albumen, it would be at once apparent that the absence of a nutritive fluid necessitated other nutriment for the developing egg; but VEJDOVSKY has specially described the albumen in the cocoon of *Rhynchelmis*—an Oligochaet with very large ova. A free larval stage in one group or the other might also get over the difficulty; but there is none such; in all the Oligochaeta whose development is known—not a very large series it must be admitted, but still a series comprising representatives of genera with large and genera with small ova, the young leave the cocoon at approximately the same age; there are at least no striking differences in this particular.

Among the vertebrata it is always possible to trace some connexion between the abundance of yolk in the ovum and the needs of the embryo; for example, the ova of *Amphioxus* have little yolk and are minute in size; this is correlated with the fact that the young are hatched in an immature condition; in the mammals there are of course special provisions (the placenta) to prevent the otherwise early hatching of the embryo; the frog which has much more yolk leaves the egg in a tolerably advanced stage of development; finally the bird and reptile is hatched in the practically adult condition. Nothing of the kind occurs in the Oligochaeta.

I formerly attempted to show that there was truth in the idea that the nature of the ova is correlated with the habitat of the worm; the ova of *Allurus* which is an aquatic form though related to the terrestrial genera are apparently larger than those of *Lumbricus*; the difference, however, is not by any means an obvious one; moreover, I since found that the nearest approach to the ova of the 'Limicolae' among the Terricolae was to be seen in *Moniligaster*; here we have ova which are filled with large yolk spherules as large as those of, for instance, *Tubifex*; *Moniligaster* is purely a terrestrial genus so far as we know.

The mature egg of *Rhynchelmis*, which may be selected as the type of a large

yolked ovum, is spherical; it has a peripheral and extremely fine membrane, beneath which is a dense layer of protoplasm; connected with this is a protoplasmic network which ramifies through the entire egg and in the meshes of which are contained the yolk-spherules. The spherical nucleus is surrounded by a distinct doubly-contoured membrane. Around this membrane is a dense layer of protoplasm with a radial arrangement of its particles; but the membrane seems to be imperforate. The contents of the nucleus show an obscure meshwork in the interstices of which is a granular nucleoplasm; there are as a rule two nucleoli, of a spherical contour; the substance of these can be differentiated into two layers; outside there is a radially striate coat within which is the granular core. The ovum is elaborately figured and described by VEJDOVSKY, to whose work reference must be made for further details (**9**).

Among the Megadrili the most aberrant ova are those of the Eudrilidae. Like other Megadrili they are of small size owing to the small development of the yolk. As in *Lumbricus*, there is a membrane covering the egg externally; but this membrane is greatly developed in many Eudrilids. In *Lumbricus* it is an excessively fine membrane as in *Rhynchelmis*; but in *Hyperiodrilus* there appear to be two distinct membranes. The ovum is surrounded by a very thick, darkly staining membrane which is traversed by numerous pores; beneath this is a fine membrane which I regard as the probable equivalent of the vitelline membrane of *Lumbricus*. The egg-protoplasm has a distinctly reticular arrangement, and the nucleus has also a membrane separating it off from the surrounding protoplasm. The ova of *Heliodrilus* appear to possess much the same structure. In *Eudrilus* the ovum has a thick membrane, exactly like the thick outer membrane of the ovum of *Hyperiodrilus* in minute structure; but it has the remarkable peculiarity of being confined to one pole of the ovum; it does not extend right round. The structure of the ovum of this Annelid has been treated of by HORST and myself. HORST (**8**) speaks of this peculiar membrane as a protoplasmic mass formed of filaments which have the appearance of cilia. The membrane must, I think, in spite of the fact that it is only partial, be compared to that of *Heliodrilus*. The comparison seems to favour my opinion that the membrane in question is not a product of the ovum, but is produced by the modification of the follicular cells surrounding the growing egg. If it were a product of the egg protoplasm it would surely surround the entire circumference of the egg in *Eudrilus* no less than in *Heliodrilus*. I shall recur to this 'membrane' in describing the egg-development.

Development of the ova.—There appear to be three types of egg-development in the Oligochaeta.

The more prevalent type is seen in all earthworms except certain Eudrilidae, and in a large number of the aquatic Oligochaeta; it is met with, for example, in the Lumbriculidae and most Tubificidae. VEJDOVSKY has described in great detail the facts for *Rhynchelmis* which I shall therefore take as an instance. The youngest eggs are indistinguishable from the mass of ovarian cells among which they lie in the egg-sacs; the cells appear to be amoeboid in their youngest stages; this is inferred from their frequent pear-shaped character and from the fact that they are not always in continuous contact. Any of these cells, it may be inferrred, may develop into ova. As the egg-cell grows its peculiar characters already described gradually differentiate themselves; the nucleolus is at first of course single and its bipartition has been observed; no share whatever appears to be taken in the development of the ovum by the surrounding cells; at any rate no changes are noted in them by VEJDOVSKY. In *Lumbricus* the mature ovum has, what it has not in *Rhynchelmis*, a distinct follicular layer of flattened cells; it is possible that these cells do bear a part in the maturation of the ovum; but apart from this follicle no changes are observable in the remaining cells of the ovary which are not on the way to become ova.

The second method of egg-development differs from that just described in the important fact that certain of the cells of the ovary do apparently take a share in the formation of the ovum by contributing to its nutrition; this way of development has at present only been observed in *Eudrilus* by myself and HORST. Our observations agree in all essentials. The development here, as in *Rhynchelmis* and many other worms, takes place in the egg-sacs. At first the young ova are seen lying among a quantity of indifferent cells; any of these, it is to be presumed, possess the capability of becoming ova; later the cells in the immediate neighbourhood of the more mature ova gradually break down; the outlines become obscured and the final stage reached is a mass of protoplasmic matter in which neither cells nor nuclei can be any longer recognized, and which has a fibrous appearance; it is very possible, though I have no positive facts to go upon, that the peculiar membrane already referred to as surrounding one pole of the ovum is produced by this broken down mass of cells. The pores of the membrane in question are figured by HORST as penetrating the vitelline membrane, and he thinks that they serve as the conduits of nourishment to the ovum. There is to my mind an undoubted resemblance in the mode of development of the ovum in *Eudrilus* to the formation of the Graaffian follicle in the higher Mammalia; in the latter, the liquor folliculi is produced by the breaking down of cells of the follicle, at least partly; and this liquid may be fairly compared to the perhaps fluid

protoplasmic mass referred to as surrounding the mature and nearly mature ova of *Eudrilus*.

The third mode of development of the ova in the Oligochaeta is especially interesting, as it appears to show great resemblances to the development of the spermatozoa in the same worms. It is characteristic of the Naids, the Enchytraeidae, the genera *Ilyodrilus* and *Phreodrilus* among the Tubificidae. It has been followed out by a good many observers; the eggs in these worms consist in their early stages of masses of cells, which become detached from the ovary, and either find their way into the egg-sacs or float freely in the body-cavity. Each mass consists of a peripheral row of cells surrounding a central mass of protoplasm, which has no nucleus and does not appear to be the equivalent of a cell. I have seen in *Phreodrilus* the whole mass surrounded by a layer of flattened cells. Later one of the cells increases in size and becomes a definite ovum; when it breaks away the other cells may in their turn become ova; in this case the development is almost exactly that of the spermatozoa, the only difference being that the peripheral row of cells are not simultaneously converted into sexual elements. In the early stages of the ovarian development of *Ilyodrilus* STOLC (**3**) represents the immature ova as not separated by distinct boundary lines from the central non-nucleated mass.

The spermatozoa and their development.—The spermatozoa in the Oligochaeta are always filiform bodies and possess the power of free movement. As a general rule there is no thickening at one end; this was only observed by VEJDOVSKY in the Lumbriculidae. The development of the spermatozoa has been studied by a large number of naturalists; the reader is referred to BLOOMFIELD and NASSE especially for details upon this subject. The principal facts appear to be the following: the sperm undergoes its development in the sperm-sacs in those worms (the majority) which possess these structures; the sperm mother-cells divide in such a way as to form a peripheral layer of cells, not at first marked off from a central, generally unnucleated mass of protoplasm; this latter has been termed the cytophore or the sperm-blastophore; this structure is simply the remains of the mother-cell, and possibly serves to nourish the growing spermatozoa; it is evidently to be compared to the central mass of protoplasm round which the ova of *Phreodrilus*, &c. are developed.

§ 2. *Sperm-sacs.*

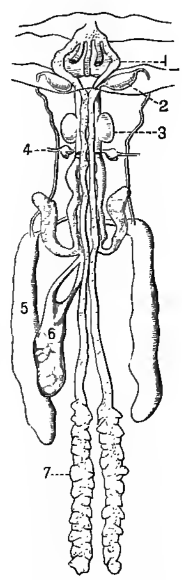
Nearly all the Oligochaeta possess sacs in which the sperm undergoes most of the stages of its development, and which are on that account termed sperm-sacs; this name is preferable, on the whole, to the earlier name of 'vesiculae seminales,'

because that term suggests a comparison with the similarly named structures of vertebrates, which are a part of the efferent apparatus; at first the structures now known to perform the function of harbouring the sperm were regarded as testes; in spite of the discovery by HERING of the real testes, the sperm-sacs were persistently termed the testes by almost everybody. From the fact that the sperm-sacs always appear to contain Gregarines, these organs were once regarded as ovaries—the Gregarines when encysted being mistaken for the ova; D'UDEKEM'S discovery of the ovaries disposed of this view as well as of the alternative view due to VON SIEBOLD that the sperm-sacs were hermaphrodite glands.

Their true nature was first pointed out by HERING who called them 'Samenblasen.' The development (in *Lumbricus*) was first elucidated by BERGH, whose discoveries finally disposed of the theory that the organs were testes. The sperm-sacs originate from the intersegmental septa, as outgrowths of the same; they contain from the first a cavity which is continuous with the cavity of the segment from the wall of which they arise; this cavity is therefore coelomic; later on it is divided up into a series of inter-communicating spaces by the complicated growth of the walls; but none the less the internal cavity remains coelomic, and the epithelium found within it is peritoneum. The sperm-sacs are in fact coelomic sacs set apart for the maturation of the sperm. It is usual to distinguish between the paired sacs and median unpaired sacs which enclose, when present, the gonads, the ventral blood-vessel and even the nerve-cord, besides of course the funnels of the sperm-ducts. These communicate in the adult with the paired sacs; the name sperm-reservoirs may be applied to the former, that of sperm-sacs may be reserved for the latter. As to the origin of the sperm-reservoirs there does not appear to be much positive information; BLOOMFIELD thinks that they are due to a coalescence between the paired sacs; BERGH is not apparently inclined to back up this view. It can hardly be doubted that they originate from the septa as do the paired sacs; they differ, however, in structure to a certain extent; the cavity of the paired sacs, as has already been stated, is subdivided into numerous cavities; that of the median sacs is not so divided; the median sacs are by no means always present; they are absent, for example, in the genus *Allolobophora*; they seem also to be absent in *Acanthodrilus* and in a number of other forms. In these genera it of course follows that the gonads and the sperm-duct funnels hang freely into the cavity of their respective segments. It is not always possible to refer a given structure to one of these two series of sacs; the matter becomes easier if we agree to apply the term sperm-reservoirs to those sacs which enclose the gonads and the funnels, reserving the term sperm-sacs for diverticula of the septum which do not

enclose these organs. Looking at the matter in this way, the sacs in *Moniligaster* must be regarded as sperm-reservoirs, although they are paired; the sacs in question enclose the gonads and the funnels, and it will also be noticed that their cavity is undivided by trabeculae—another feature which characterizes the sperm-reservoirs of *Lumbricus* in contradistinction to the sperm-sacs. It appears from the results obtained by BERGH and VEJDOVSKY that the paired sperm-sacs are developed before the median sacs; hence it would seem just to regard these sacs as older than the median sacs. It is conceivable that the median sperm-reservoirs of earthworms are more strictly comparable to the generally impaired and very voluminous sacs found in the aquatic Oligochaeta, than are the sperm-sacs.

Fig. 26.



POLYTOREUTUS. REPRODUCTIVE ORGANS.

1. Anterior end of sperm-sacs. 2. Dilated region of sperm-duct. 3. Calciferous gland. 4. Oviduct. 5. Spermiducal gland. 6. Spermathecal sac. 7. Posterior end of sperm-sac.

In only one family of Oligochaeta are the sperm-sacs nearly always absent, this family is the Enchytraeidae; the genus *Mesenchytraeus*, however, has paired sperm-sacs, which originate from the septum bounding posteriorly the segment in which the male gonads lie. The number and arrangement of the sacs varies considerably in different genera, thus affording valuable characters which are sometimes of specific value only. The number of the sperm-sacs varies from one to four pairs. The aquatic forms have only a single pair or a single sac which usually extend through a large number of segments, enclosing the egg-sacs in many cases, as in *Rhynchelmis* figured by VEJDOVSKY (**9**). In the terrestrial worms the sperm-sacs are as a rule of comparatively small size; they rarely occupy more than a single segment. There are various exceptions to this rule, however; and these exceptions always concern species or genera in which the number of the sperm-sacs is reduced to one pair. The most remarkable instances are *Polytoreutus* (Woodcut, fig. 26) and *Trichochaeta*; in both of these genera there is one pair of sperm-sacs which extend backwards through twenty or thirty segments; the extent of these sacs is only paralleled by certain aquatic genera such as *Rhynchelmis*. It is true that when the sperm-sacs are of such an extraordinary length they are thin; but in spite of this the total space enclosed by them is greater than in the case of the genera where there are two or three pairs of sperm-sacs only, occupying a single segment each; unfortunately our knowledge of the economy of these worms does not at present permit of any explanation of these remarkable divergences.

NEULAND has recently recurred to the earlier view respecting the sperm-sacs; he considers

that the sperm-sacs are to be regarded as a testis; but in putting forward this somewhat belated theory, the author has forgotten the development of the organs in question. However these are the grounds upon which the identity of the sperm-sacs with testes is based.

The testes as first described by HERING were not always to be found in the situation where he described them; bodies identical in every particular with these testes—so much so that one might have served as a model for the other—were found in the sperm-sacs ('Samenblasenanhänge'). NEULAND also points out that younger spermatogonia were found in the extremities of the sperm-sacs than in the more proximal regions; the reverse ought to be the case were the developing sperm-cells derived entirely from the testes (of HERING); the nearer to the testes the less advanced ought to be the spermatogonia. HERING has figured the mouth of the sperm-duct as nearer to the testes than to the mouth of the sperm-sacs; why therefore, asks NEULAND, does not the unripe sperm get into the latter? As is known this does not take place. Another matter raised by NEULAND is the immense amount of sperm produced—an amount too excessive to have been produced only by the testes of HERING.

Even if it be true that germinal tissue is produced in the interior of the sperm-sacs—which as yet wants confirmation—it is not clear how this proves the contention that the sperm-sacs are testes; in a loose sense of the word they might be called so; but then so they might have been before, for the median sperm-reservoirs contain the true testes; no doubt the whole structure may be called a testis in the same sense that the testis of *Astacus* is so called, or even the testis of the vertebrate which contains besides the germinal tissue other structures.

§ 3. *Egg-sacs*[1].

In the majority of Oligochaeta the ova when ripe or nearly ripe are transferred to certain sacs in which they remain for a time before being extruded from the body; these sacs are enormously developed in all the aquatic Oligochaeta, but appear to be rudimentary structures in most of the terrestrial forms. In *Rhynchelmis*, for example, the egg-sacs extend back as far as to the fifty-fourth segment, or even in more mature individuals to the sixty-seventh. In other aquatic families similar sacs are to be found; they are comparatively as large in the Tubificidae and Naidomorpha.

NASSE has described their development in *Tubifex*: they originate as outgrowths of the dissepiment xi/xii; into these sacs the sperm-sacs are pushed as they develop; and thus in the mature worm we have two sacs one within the other, the outer of which contains ova and the inner sperm; the same is also the case with *Rhynchelmis*, where VEJDOVSKY (**9**) speaks of the egg-sacs and the sperm-sacs lying within and enclosed by a common membrane; it should be observed that these sacs are paired, lying one on each side of the intestine (see VEJDOVSKY **9**, Pl. III, fig. 1 *o. s.*, fig. 2). But the egg-sacs are not always paired; in *Stylaria proboscidea* (cf. TAUBER **2**, Pl. XIV, fig. 1 *o. v.*), for instance, and in other

[1] Often called Receptacula ovorum.

Naidomorpha the egg-sac is a single structure surrounded anteriorly by the sperm-sac; the same statement holds good for other Oligochaeta, indeed for the majority of the aquatic forms; in *Tubifex* there is only a single sac, such too is the case with *Mesenchytraeus*. VEJDOVSKY (**24**) indeed seems to imply that unpaired sacs are the rule, for he states in a footnote to p. 137 of his 'System und Morphologie' that only in *Rhynchelmis* are the sperm-sacs, and, as we know, the egg-sacs, paired; the remark in the text to which this footnote is appended runs as follows:—'Sowohl die Samen- als Eiersäcke sind unpaarig,' &c. The paired condition, however, seems to be usual in the Lumbriculidae, for it is met with in *Sutroa* as well as in *Rhynchelmis*; the formation of the egg-sacs in the aquatic Oligochaeta seems to be merely a pushing out of the septa, caused, perhaps, by purely mechanical reasons: i.e. the large size of the ova and the pressure which they must consequently exert as they are driven backwards by the development of those in front; I have figured in the genus *Phreodrilus* the first commencement of the egg-sac, where it is nothing more than a bulging of the septum (**21** Pl. II, fig. 31). The egg-sacs were generally termed 'ovaries' just as the sperm-sacs were called erroneously 'testes'; the excuse for this error was in many cases the fact that the ovaries in the sexually mature worm had entirely broken up into clumps of developing ova, leaving no trace of their former existence.

Among the terrestrial genera it is only in the family Moniligastridae that the egg-sacs are at all large; here they may extend through three or four segments; they are always paired sacs and enclose the numerous ripe ova; as the Moniligastridae are the only earthworms with comparatively large ova loaded with abundant yolk, there almost appears to be some connexion between the large size of the egg-sacs and this fact; for in the aquatic Oligochaeta, also, the ova are loaded with yolk spherules.

The minute egg-sacs of *Lumbricus* were first discovered by HERING who wrote as follows:—'Der innere Rand des Trichters reicht an den Darmkanal; am oberen Rande ist ein kleines, durch das Septum in den vierzehnten Ring hineinragendes Knötchen angewachsen. . . . Am oberen Rande (der Tuba) stülpt sich die Wand zu einem kurzen Fortsatz aus, der durch das Septum tritt und im vierzehnten Segmente mit einer bläschenförmigen Erweiterung endigt. Dieses ist das erwähnte Knötchen. Es zeigt eine sehr verschiedene Breite, durchschnittlich 0·5 mm., und ist von einem dichten Gefässnetz umstrickt, dessen einzelne Gefässe bisweilen einen Durchmesser von 0·03 mm. erreichen. Unter dem Mikroscop ist es schwierig, den Zusammenhang dieses Organes mit der Tuba nachzuweisen, weil diese sich nicht von dem muskulösen Septum gänzlich isoliren lässt, so dass jedes klare Bild unmöglich

wird. Man kann indess jeden Zweifel dadurch heben, dass man bei mässiger Vergrösserung die natürliche Spitze eines feinen Haares von der Tuba aus in das Bläschen eindringt. Dies gelingt ohne Schwierigkeit und man sieht unter dem Mikroscope deutlich wie die Haarspitze an der hinteren Wand des Bläschens angelangt sich umbiegt. In den meisten Fällen fand ich in demselben Eier, 1–5 an der Zahl, von gleicher Beschaffenheit und grösser, als die im Ovarialzipfel enthaltenen und es liegt nahe, es als einen kleinen Eihalter anzusehen, in dem sich die Eier ansammeln, um dann gemeinschaftlich in eine Eikapsel entleert zu werden. Der grosse Gefässreichtum des Organes weist auf Absonderung einer Flüssigkeit hin, die vielleicht den Transport der Eier durch den Eileiter erleichtert. Der letztere ist ein mit zahlreichen Gefässen umstrickter Kanal, ausgekleidet von einem, &c.[1]'

The development of these egg-sacs in *Lumbricus* has been studied by Bergh (**5**); he has shown that they originate as thickenings of the septum xiii/xiv, which later become excavated and communicate with the cavity of the thirteenth segment by a small aperture; their interior is broken up, by anastomosing trabeculae, into numerous compartments which lodge the ova; the oviducal funnel just reaches the interior of the sperm egg-sac as is shown diagrammatically in the sketch given by Goehlich: this clearly facilitates the passage of eggs from the sac to the exterior. The investigations of Bergh already referred to have plainly shown that the egg-sacs are quite homologous structures to the sperm-sacs; both have the same minute structure and originate in the same way.

The cavities of the egg-sacs are of course portions of the coelom, and they are lined like the rest of the coelom by peritoneal epithelium; the rest of their walls is muscular tissue.

In other genera of earthworms egg-sacs are to be found; but it is doubtful, in some cases at any rate, whether they have any function and are not rather to be regarded as rudimentary organs. Thus in *Criodrilus* egg-sacs exist; the ova found in the interior are according to Collin[2] (**1**) smaller than the ripe ova within the ovary itself; this may argue that the ova become degenerate in the egg-sacs or perhaps that this sac is a sort of forcing house for the ova—only the comparatively unripe ova finding their way thither to attain maturity; the fact that the egg-sacs have abundant blood-vessels in their walls, which indeed often renders them

[1] These egg-sacs were passed over by both Lankester (8) and Claparède (1) in their accounts of the structure of *Lumbricus*; Horst, on the other hand, has described and figured them (11). And they have been recognized by all subsequent observers.

[2] Who figures as an abnormality the egg-sac of one side of the body depending from septum xiii/xiv into the interior of the thirteenth segment.

extremely conspicuous to the naked eye in spite of their minute size, seems to indicate that they have some function. In the large and important family of the Eudrilidae there appear to be invariably a pair of egg-sacs present; but in every case the egg-sacs appear without doubt to be functional though they are no larger or but little larger than in *Lumbricus*; in this family the passage of ova into the egg-sacs is nearly always facilitated by peritoneal sacs, which enclose the ovaries and form a closed duct leading to the egg-sacs; I refer again to these in describing the Eudrilidae. In all the Eudrilidae the egg-sacs in mature individuals contain not merely ripe ova, but ova in various stages of development surrounded by masses of ovarian cells; this state of affairs is similar to what is found in the lower Oligochaeta, where masses of cells are broken off from the ovary and find their way into the egg-sacs, where they undergo further development; in these cases, therefore, there is a closer likeness as regards function between the egg-sacs and the sperm-sacs, for in both the genital products undergo at least the final stages of development; whereas in *Lumbricus* only ripe ova without any attached cells lie in the egg-sacs.

One pair of egg-sacs have been found in the same segment (the fourteenth) in the Acanthodrilidae, the Cryptodrilidae, Geoscolicidae, and certain Perichaetidae; as a rule egg-sacs seem to be absent from the smaller and degenerate species; thus they do not appear to exist in *Ocnerodrilus* or in *Gordiodrilus*. In many Perichaetidae the egg-sacs are interesting from the fact that there are two pairs of them; I have pointed out that to the two pairs of testes correspond as a rule two pairs of sperm-sacs; now there does not appear to be any earthworm in which there are normally two pairs of ovaries, though in many there are traces of a second pair, especially in development[1]; we should expect, therefore, that originally, at any rate, two pairs of egg-sacs existed in correspondence to these two pairs of ovaries. And in the genus *Perichaeta* (*s. s*) there are several examples of species in which there are two pairs of egg-sacs. BERGH (**5**) has remarked upon the presence of two pairs in a species nearly related to HORST'S *Perichaeta hasselti*; one pair occupy the normal position, the other lie in the thirteenth segment just above the ovaries; this is, it will be observed, precisely the position that the second pair ought to occupy, for the missing ovaries belong to the twelfth segment. I have found two pairs of egg-sacs in other species of *Perichaeta* similarly placed. In *Perichaeta* I have noticed that these egg-sacs are often rather larger than in *Lumbricus*, and that they are of an elongated form perhaps more like the sperm-sacs in

[1] See WOODWARD (1, 2) for occasional presence of many ovaries.

shape than is usually the case; in considering the possibility that *Perichaeta* is an archaic type of earthworm, the existence of two pairs of egg-sacs is of some importance. BERGH found nothing in the egg-sacs of the species investigated by him but *Pseudonavicellae* and darkly pigmented bodies; he comments upon the fact that the funnel of the oviduct does not open into the interior of the egg-sac as it does in *Lumbricus*, and suggests on this account that the bodies are functionless. They are certainly not always functionless in this group of earthworms; I found in *Diporochaeta intermedia* a pair (one only) of egg-sacs in the usual position which were full of developing ova, each surrounded by a mass of nutritive cells; these egg-sacs had no communication with the oviducts, but the fact that they contained so many eggs, both fully mature and developing, seems to dispose of the view that, when there is no connexion with the oviduct, the egg-sacs are without function. In the species just referred to the egg-sacs contained abundant Gregarines which I have also met with in the egg-sacs of *Eudrilus*; this is another resemblance to the sperm-sacs, where these parasites are invariably to be seen.

§ 4. *Sperm-ducts.*

Special conduits for the semen are found in all Oligochaeta, with the sole exception of the genus *Aeolosoma*. In that worm, according to the recent researches[1] of STOLC (**1**) true sperm-ducts do not exist; the nephridia of *all* the segments of the body conduct the spermatozoa to the exterior; this was proved by direct observation; although the spermatozoa may escape by any of the nephridia (some of the nephridia disappear wholly or in part during the period of sexual maturity), those of the sixth and neighbouring segments especially take upon themselves the function of sperm-ducts, and they are figured by STOLC as rather larger than the others.

When true sperm-ducts are developed there are never more than two pairs of them[2]; and frequently only a single pair exist. Each sperm-duct consists of (1) a wide funnel-shaped opening into the coelom and (2) a tube more or less contorted which opens directly on to the exterior or through (3) a terminal chamber, the spermiducal gland, which will be described in the next section.

Both the funnel and the tube are ciliated throughout. The funnel varies very much in form. In the simpler aquatic forms, and in some of the smaller terrestrial Oligochaeta, it is a flattened plate-shaped disc, with incurved and sometimes also

[1] PERRIER's statement that there are no sperm-ducts in *Anteus* requires confirmation.
[2] Three have been described in *Glyphidrilus weberi*; but this is probably a 'sport.'

a recurved margin. In the Enchytraeidae it has a very peculiar form; it is here barrel-shaped, with a lining of very thick glandular-looking cells, which encroach upon the lumen, reducing it to the smallest dimensions.

Among earthworms the funnel is for the most part folded at the margins, whence the term 'ciliated rosette' which is often applied to it. The folding is often extremely complex.

As a general rule the funnel of the sperm-duct opens directly into the general body cavity of the segment; sometimes, as in *Lumbricus*, &c., the funnels are lodged in special sacs—shut off from the rest of the coelom—which contain the testes, and are in communication with the sperm-sacs. The funnels commonly lie close to the posterior septum of their segment, facing forwards and opposite to the testes which usually are attached to the anterior septum of the same segment; a curious exception to this rule is seen in the Eudrilid genera *Teleudrilus*, *Hyperiodrilus*, and *Heliodrilus*—perhaps also in some others. In these genera the funnels depend from the anterior septum of their segment, and accordingly (see woodcut, fig. 26) the vas deferens perforates this particular septum twice on its way to the external pore. In the Lumbriculidae something of the same kind occurs, owing to the fact that the male genital pore lies in front of though in the same segment as the posterior funnels; these funnels face forwards and depend from the posterior septum of their segment as in the majority of the Oligochaeta; the vas deferens passes backwards perforating this septum and then again perforates it on its way to the external orifice. The number of funnels appears nearly always to correspond to the number of the testes; if there is only a single pair of testes there is only a single pair of funnels and sperm-ducts; if there are two pairs of testes the number of funnels is[1] also doubled. The position of the funnels is also in correspondence with that of the testes, that is to say as to the number of the segment which they occupy. Very rarely this is not the case. For example in *Heliodrilus* the testes lie a segment in front of the funnels, which must necessarily occur owing to the facts already mentioned about the position of the funnels. The duct arising from the funnel is a tube with ciliated epithelial walls; the cells composing it are more or less quadrangular in form and surround the lumen which is never intracellular. Outside the epithelium is a layer of peritoneum and in a few instances, e.g. in *Eudrilus*, a layer of muscles between the two. Very anomalous are the sperm-ducts of *Phreodrilus*, where the windings of the duct, which has a caecal diverticulum, are largely within the peritoneal covering; this is described more in detail below. The principal variations in the sperm-ducts

[1] Not, however, apparently in many Lumbriculidae, where *two* pairs of funnels and *one* pair of testes.

concern (1) their position in the body, (2) the point of opening on to the exterior, (3) the degree to which the ducts of one side of the body are fused together.

As a general rule the sperm-ducts lie in the body cavity; this is always the case in the lower Oligochaeta where they are frequently much coiled; even in the higher Oligochaeta (earthworms) where the ducts (except in *Moniligaster*) pass in an approximately straight course from funnel to pore, the sperm-ducts lie a little above the ventral parietes.

In *Lumbricus* (cf. NEULAND, fig. 4) and other forms the sperm-ducts lie just within the peritoneum.

The sperm-ducts lie deeper still within the tissues of the body-wall in a few other earthworms. I found this to be the case with *Acanthodrilus annectens* and have since recognized the same thing in *Acanthodrilus paludosus* and in a worm belonging to a totally different family, viz. *Siphonogaster millsoni;* in these examples as well as in *Diplocardia communis* (GARMAN, **1**) the sperm-ducts are imbedded deep within the longitudinal muscular layer. It is quite possible that in other earthworms whose sperm-ducts have not been seen, the reason for their invisibility in a dissection is due to their lying in this position.

Finally the genus *Sparganophilus* (Fam. *Geoscolicidae*) is unique by reason of the fact that the sperm-ducts lie deeper still or more superficially in reality. They are placed just beneath the epidermis; in the clitellar region the duct lies at first below the entire epithelium; nearer to the pore it comes to be just underneath the superficial epidermis of the clitellum.

The position of the external orifice differs greatly and is but rarely characteristic of a family. As a general rule the two sperm-ducts of each side unite to form a single tube with a single orifice. In *Phreoryctes,* however, the two sperm-ducts open on to as many consecutive segments; they have absolutely no connexion with each other. An intermediate condition is to be seen in the genus *Pelodrilus;* here there are two quite separate sperm-ducts which, however, open near to each other on the same segment. In the Acanthodrilidae there is a still more marked foreshadowing of a fusion between the two sperm-ducts, for they join just before the external orifice. In the majority of earthworms, for example in the Perichaetidae, the two sperm-ducts join as soon as they can, i.e. in the twelfth segment.

§ 5. *Oviducts.*

In the lower Oligochaeta there are no special conduits for the ova; the genus *Aeolosoma* is provided with a pore upon the median ventral surface of the sixth

segment; this pore has been figured by D'UDEKEM (**2**), and by STOLC (**1**), whose account, though establishing that of D'UDEKEM, is more recent, and being the result of more refined methods of investigation is important if only as a confirmation of the earlier description.

Among the Naidomorpha similar pores appear to exist. It is among the Enchytraeidae that we first meet with indications at least of special tubes which conduct the ova to the exterior; the structure of the oviducts in this group of the Oligochaeta is such as to suggest a degenerate condition. BUCHHOLZ controverted the opinion of D'UDEKEM that the sperm-ducts served as the conduits for the ova also, and suggested that there might be simple pores in the skin through which the ova made their way to the exterior; such pores, however, were not found, though BUCHHOLZ believed that they were probably small, owing to the ease with which the ova could alter their size. CLAPARÈDE (**3**) described in *Enchytraeus vermicularis* a pair of orifices upon the twelfth segment (this position is erroneous); these orifices were figured (Pl. II. fig. 80) by CLAPARÈDE as existing on the same segment as that which bears the male pores; this error is due to the fact that CLAPARÈDE was not aware that the setae were absent on the segment which bears the male pores; hence he thought that the pair of setae behind the male pores belonged to that segment; VEJDOVSKY (**3**) verified the existence of these pores by treating the living worm with a drop or two of Osmic acid which caused the pores in question to open widely and occasionally eggs were seen to pass out of them. They were, however, regarded as mere pores by VEJDOVSKY and by MICHAELSEN (**4**) in his account of *Enchytraeus moebii*. MICHAELSEN, however, spoke of 'trichterförmige Einsenkungen des Dissepiments 12/13 in das 13. segment.' And in his many subsequent papers upon this group of Oligochaeta he used the same expression. I have given (**49**) a figure of the oviducts of *Pachydrilus;* they appear to consist of a few pear-shaped cells, not ciliated, which fringe the orifices. The degeneration of these structures is curiously paralleled by the degeneration of the spermathecal duct in *Nemertodrilus*, where an orifice only has been left fringed with very similar cells on its coelomic side.

The oviducts in the Tubificidae and Lumbriculidae are very similar to each other. The curious belief that in the former the oviducts form a sheath to the spermiducal gland I deal with later. The oviducts in this family, so far as they are known, are, as in the Lumbriculidae, short tubes which open into the coelom by a wide funnel. It is in the earthworms that the oviducts form long tubes, but not everywhere. Generally, indeed, the large funnel is followed by a very short tube leading to the exterior. In such cases, e.g. *Lumbricus, Perichaeta*, the oviduct is very little more

differentiated than in the Lumbriculidae. But among the Eudrilidae, for example in *Libyodrilus*, it is of considerable length, and not unfrequently possesses a muscular sheath. In *Alvania* it has even a caecum lying close to it and bound up within the same sheath. The position of the oviduct or oviducal pore, as the case may be, varies in different families. It is remarkable that in all Megadrili the oviducal ducts open on to the exterior in the fourteenth segment. *Rhinodrilus proboscideus* may be an exception, but the statement that the ovary lies in the seventeenth segment requires confirmation. In *Libyodrilus* the oviducal pores appear to be on the fifteenth segment, but a dissection of the worm shows that the septum dividing the fourteenth and fifteenth segments lies behind the point of opening of the ducts.

Considering the close agreement between the male and female gonads the differences between their ducts are perhaps more striking than the resemblances. There is the general agreement that both consist of ciliated tubes opening into the coelom by a wide funnel, often hidden within sperm-sacs or egg-sacs[1]. In both cases the ciliated tube consists of a single layer of cubical cells, which may be surrounded by a muscular layer in addition to the peritoneal coating. The caecum of the oviduct in *Alvania* may be compared to the caecum of the sperm-duct in *Phreodrilus*. In *Phreoryctes* too, which appears to me to be undoubtedly an archaic type, the oviducts and sperm-ducts (there are two pairs of each) not only correspond in number and structure, but the last pair of sperm-ducts is shorter than the first pair and is therefore intermediate in length between it and the oviducts.

In the Microdrili, indeed, the sperm-ducts and the oviducts agree in never occupying more than two segments, the funnel lies in one segment and the external pore is in the following one or rather between the two, and there is a relation between the position of one orifice and the other (see Table above, p. 85).

In the Megadrili the oviducts invariably occupy only two segments, while the sperm-ducts nearly as invariably[2] occupy more than two segments. There is, moreover, no ascertainable relation between the position of their pores, as the one varies, while the other remains fixedly constant. The coiling of the sperm-ducts is not paralleled by the oviducts; and the latter are never connected with glandular structures like the spermiducal glands. An apparent exception to this last statement is shown by *Eudrilus*, where the oviduct opens in common with the spermathecal sac and a glandular diverticulum apparently belonging to the same. This connexion, however, is probably hardly comparable to the connexion between sperm-ducts and spermiducal glands, since it is so rare among the Eudrilids (where alone it is found).

[1] Most completely in Eudrilidae.

[2] One exception is probably *Tetragonurus*.

§ 6. *Development and Homology of the reproductive ducts.*

The generative ducts of the Oligochaeta have for a long time been believed to have some connexion with the nephridia, but the precise nature of this relation has only quite recently been cleared up; the oviducts are more like nephridia in the higher forms than are the sperm-ducts; to begin with they occupy precisely the same number of segments as does a nephridium; the funnel opens into one segment and on the segment behind this is the external pore. This is also the case with the sperm-ducts of the Microdrili but not of the Megadrili. CLAPARÈDE found that the genital ducts in the 'Limicolae' never coincided with nephridia and thus came to the conclusion that they were the modified equivalents of the latter. His observations turn out, however, to have been inaccurate; for, although in the adults of the worms there are no nephridia in the segments which contain the genital-ducts, the nephridia are there in the immature worms, and only disappear on the appearance of the latter. The views of CLAPARÈDE were extended to *Lumbricus* by LANKESTER, who pointed out that there was some evidence of the primitive existence of two pairs of nephridia per segment in that worm, one series being complete the other represented only by the genital ducts; the intimate relation between the nephridiopores and the orifices of the genital ducts and the setae on the other hand led to this view, which was subsequently strongly supported by PERRIER. This naturalist found that in some earthworms the nephridiopores were related to the dorsal instead of to the ventral setae as in *Lumbricus*, thus showing the persistence of the presumed second series of nephridia, the nephridia of *Lumbricus* being only partially persistent in the genital ducts of those worms of which *Anteus* was an instance. Later PERRIER found a worm (*Plutellus*) in which the nephridia alternated in position, now opening by the dorsal now by the ventral setae; in this case, therefore, the assumption was that both sets of nephridia partially persisted. The discovery of the occasional coincidence of a nephridium and a genital-duct at the same seta finally led PERRIER to abandon the hypothesis. This difficulty was removed by my own discovery of the multiple nephridial pores of *Octochaetus* and other genera; and during the progress of PERRIER's researches the discoveries of BALFOUR and SEMPER of the connexion between the excretory and genital systems in the Vertebrata of course strengthened the views which favoured the probability of a similar connexion in the Oligochaeta. Nevertheless facts seemed to be against any such homology. The development of *Lumbricus* showed, or appeared to show, the entire independence of the two sets of structures (see BERGH **5**). On the other hand STOLC, from his investigations into the anatomy of the sexual organs of the genus *Aeolosoma*, supported the view;

he found that in that Annelid the male-ducts were represented by slightly enlarged nephridia; an argument derived from a study of the embryology of an Enchytraeid led ROULE to the same conclusion; he states that the segments in which the male-ducts will appear have no nephridia, but that the male-ducts appear rather late and so suggest the idea of a pair of slightly modified nephridia which are delayed in appearance in connexion with their changed function. SPENCER and I at one time argued against the connexion between the excretory and genital-ducts from the ground that in *Perichaeta*, which we believed to represent a highly archaic form, the genital ducts showed no trace of their supposed origin from nephridia, the latter being in a very primitive condition. SPENCER also pointed out that the genital ducts have an intercellular lumen while the nephridia have an intracellular lumen ; this argument is, however, at best not a strong one, and, as has been mentioned, VEJDOVSKY says that the lumen in the nephridia is really also intercellular. The only positive evidence as to a connexion between the nephridia and the genital-ducts has been brought forward by myself. In *Octochaetus multiporus* the genital-ducts appear to be formed out of a part of the pronephridia, thus confirming the suggestion of BALFOUR (Comp. Embryol. vol. ii. p. 617) that 'in the generative segments of the Oligochaeta the excretory organs had at first both an excretory and a generative function, and that as a secondary result of this double function each of them has become split into two parts a generative and an excretory.' The actual facts which I brought forward upon the development of the genital ducts are the following: at a comparatively late stage in the development of this worm, after the pronephridia have lost their distinctive character and have acquired numerous openings on to the exterior, the proximal part of the nephridium which consists of the remains of the funnel (the cilia have disappeared) and a straight tube leading to the body-wall separates off from the rest of the nephridium ; the funnel grows and re-acquires cilia; the tube grows into the body-wall and becomes the genital duct; the genital ducts have precisely the same structure at first whether they are to become oviducts or sperm-ducts; they are, moreover, only to be distinguished from the corresponding remains of the funnel and the first part of the nephridium in the preceding and succeeding segments by their larger size ; it should be mentioned also that there are at first traces of four genital ducts in correspondence with the four gonads. It is very remarkable that in the case of four pairs only of the pronephridia the commencing degeneration should be arrested and growth recommence ; the tube, at first hollow, becomes solid and then re-acquires a lumen ; an analogy to this state of affairs is, however, offered by the occlusion (temporary) of the lumen of the oesophagus in more than one Vertebrate. The disappearance followed by the reappearance of cilia upon the

funnels is also not without its analogies; particularly among the Protozoa where the vanishing of cilia so far from being an indication of degeneration is actually the prelude of renewed activity. In any case the facts appear to be as stated in *Octochaetus*. Another point to be emphasized in connexion with the development of the genital-ducts is their early appearance in *Octochaetus* as compared with *Lumbricus*. The facts which I have made out as to the development of the genital ducts in *Octochaetus* appear to absolutely contradict the facts established for *Lumbricus* —so much so, indeed, that it seems hardly credible that both can be correct. A little consideration, however, I think shows that there is not necessarily any contradiction. In *Lumbricus* the ducts appear after the nephridia have acquired their definite form; there is every reason, therefore, why they should not show any actual connexion with them in development, since presuming their homology with the genital ducts of *Octochaetus* the latter are formed out of the remains of a part of the pronephridia. The genital ducts of *Lumbricus* are formed so late that they cannot be produced out of the pronephridia which have been in the meantime converted into the nephridia. Another point to be observed is that in *Octochaetus* the polynephric condition is to some extent established before the commencing differentiation of the sperm and oviducts. It is possible therefore to regard the existence of both in the same segment in *Lumbricus* as the last remnant of an ancestral condition where the nephridia were numerous in each segment.

As tending to prove that in some 'meganephric' worms at any rate the funnels of the genital-ducts are formed out of the funnels of the pronephridia I may say that I could find no nephridial funnel in the tenth, eleventh, and thirteenth segments of *Alvania millsoni*, but I did find them in the fifth to ninth and in the twelfth and fourteenth segments. In *Gordiodrilus* there were none in the thirteenth at any rate.

§ 7. *Spermiducal Glands*[1].

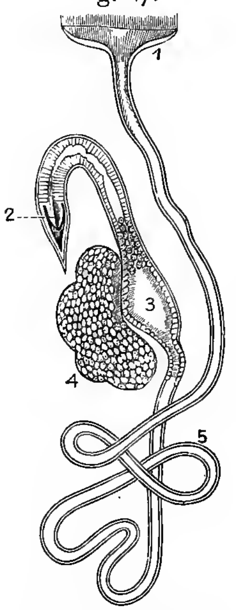
In some Oligochaeta the sperm-ducts open on to the exterior directly; in others, and these are the majority, the sperm-ducts open into a wide terminal chamber which itself opens exteriorly; this is the case with the Lumbriculidae, the Tubificidae, the Perichaetidae, many Cryptodrilidae, the Eudrilidae, the Naidomorpha, the Chaetogastridae, the Moniligastridae, the Enchytraeidae; in a limited number of genera of Cryptodrilidae and in all the Acanthodrilidae there are these glands, but the sperm-ducts open separately on to the exterior though in their immediate neighbourhood.

[1] I prefer this name, recently suggested by myself (80) to either atrium or prostate as it emphasizes the position and relation of the glands, and having been never used before has no preconceived meaning attached to it.

The Lumbriculidae, the Phreoryctidae, the Geoscolicidae (for the most part) have no such glands at all; and in these worms the sperm-duct is with a few exceptions unprovided with any glandular apparatus at its terminal orifice.

The simplest form of the terminal chamber is found, as might be expected, in the lower aquatic Oligochaeta; in the Naïds its structure is as follows: the sperm-ducts lead on each side of the body into a pear-shaped sac, which has been called the 'atrium' and opens on to the exterior in the sixth segment; this sac is lined by a glandular epithelium apparently without cilia; externally to this epithelium is a covering of peritoneal cells; the 'atrium' in *Nais elinguis* gradually passes into the sperm-duct; in *Stylaria lacustris* and in *Dero* there is an abrupt break between the two; I cannot discover any positive statements as to whether the lining cells are or are not ciliated in the Naidomorpha; there is no indication of any ciliation in the figures of STOLC (**5**) and VEJDOVSKY (**24**).

Fig. 27.



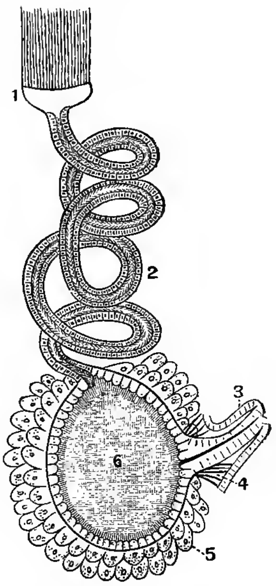
MALE EFFERENT APPARATUS OF LOPHOCHAETA.
(After Stolc.)
1. Funnel. 2. Penis. 3. 'Atrium.' 4. 'Prostate.' 5 Coiled sperm-duct.

Among the Lumbriculidae we meet with a terminal chamber which is modelled upon the same plan as that of the last family. Among the Enchytraeidae there is very commonly a homologous organ of an equally simple, though rather different structure. I follow here MICHAELSEN'S account of *Enchytraeus humicultor*. It is a rounded or oval body (called by MICHAELSEN a 'penis'), lined with long cells. It communicates with the exterior by a short invagination of the latter, which is beset with groups of unicellular glands. The sperm-duct opens at the summit of the terminal gland which has a muscular layer outside the lining epithelium.

The Tubificidae have an 'atrium' which is more complex than that of the last two families. In *Tubifex* itself, which may serve as a type of the family, the organ has been described by a large number of writers; it is an elongated sac receiving the sperm-duct at one end and opening on to the exterior at the other; the proximal part is ciliated; the distal region is not ciliated; the latter forms a protrusible penis which is described more fully in a separate section (see below). A remarkable feature of the atrium in the Tubificidae, with the exception of a few forms, is the presence of a glandular appendage variously termed 'Cement gland' (LANKESTER), 'Cementdrüse' (VEJDOVSKY), 'Prostate' (EISEN, &c.); this is a thick patch of pear-shaped glandular cells whose ducts (merely the prolongation of the cells themselves) open into the lumen; VEJDOVSKY has shown that

the origin of this body is an outgrowth of the lining epithelium of the atrium; it is a curious fact that the covering of peritoneum upon the atrium ceases at the point where the 'prostate' is attached, a fact which, if the development of these parts was not known, might give rise to the idea that the 'prostate' was nothing more nor less than a tract of peritoneum modified to serve a special function. NASSE speaks

Fig. 28.

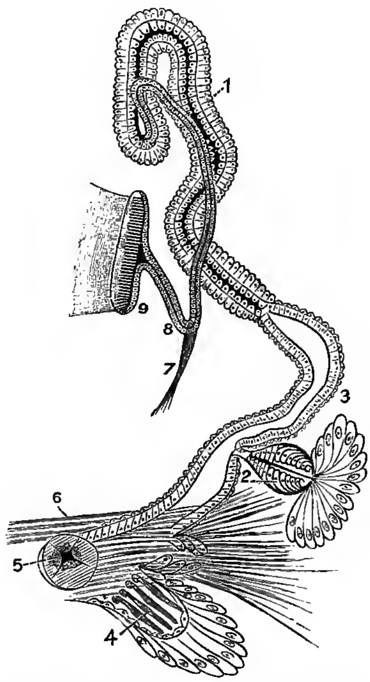


ILYODRILUS COCCINEUS.
MALE EFFERENT APPARATUS.

(After Stolc.)

1. Funnel. 2. Sperm-duct. 3. Penis. 4 Muscles for its retraction. 5. Glandular covering of 6. 'Atrium.'

Fig. 29.



BOTHRIONEURON VEJDOVSKYANUM.
MALE EFFERENT APPARATUS.

(After Stolc.)

1. Proximal region of 'atrium.' 2. 'Paratrium.' 3 Distal region of 'atrium.' 4. Penial setae. 5. External pore. 6. Muscles for protrusion of distal end of efferent apparatus. 7. Muscle attached to sperm-duct (8). 9. Funnel.

of a fine lumen to each group of cells in the prostate; but it is fairly clear that the gland is solid; the cells of which it is composed appear to correspond with other unicellular glands found so commonly among earthworms; for example, the capsulogenous glands of the Perichaetidae; the 'atrium' being developmentally an involution from the outer layer of the body it is not remarkable to find

that gland-cells are developed in connexion with it just as gland-cells frequently underlie the epidermis.

This form of atrium is found with but slight modifications in the majority of the genera of Tubificidae (woodcut, fig. 27); *Ilyodrilus* (woodcut, fig. 28) has, however, an atrium precisely similar to that of the Naidomorpha; in *Bothrioneuron* and in *Branchiura* the atrium is rather different, and the state of affairs characteristic of these two genera suggests another interpretation of the morphology of the parts in *Tubifex;* in both these last mentioned Tubificidae (woodcut, fig. 29) the vas deferens widens out into a terminal chamber which appears to be the atrium; but this is provided with a single lateral diverticulum (fig. 29, 2), very much larger in *Branchiura* than in *Bothrioneuron;* in *Branchiura* the lateral chamber has precisely the structure of the atrium in the Lumbriculidae. It is joined by the sperm-duct just where it passes into the muscular atrium; there can be no doubt in my opinion of the relationship between *Branchiura* and *Tubifex;* hence we should expect to be able to furnish a comparison of the different parts of the efferent ducts in each; two views seem to be possible; either we must simply consider that the sperm-duct has come to open into the atrium some way from its extremity, or we must regard the sac-like appendix as the equivalent of the prostate of the typical Tubificidae; in this event the solid character of the prostate in the latter will be a secondary matter; Stolc (**3**) is apparently of opinion that the small lateral caecum attached to the atrium of *Bothrioneuron* (called 'paratrium' by Vejdovsky) is the homologue of the prostate of other Tubificidae, as he indicates both by the same letters in his plates.

The genus *Telmatodrilus* has an 'atrium' which is intermediate in character between that of *Tubifex* or *Psammoryctes* and the more typical Tubificidae on the one hand, and *Branchiura* and the Lumbriculidae on the other: in that genus Eisen described and illustrated the presence of a series of separate 'prostates' opening at intervals through gaps of the proper walls of the 'atrium' into its interior; if these separate masses of glandular cells were combined into a continuous glandular structure we should have an 'atrium' exactly like that of Lumbriculidae, except for the absence of muscles.

In the Megascolicidae the corresponding organ is constructed upon one or other of two types. In *Acanthodrilus*, for example, it is a tubular structure of varying length, occupying more or fewer segments, coiled or straight, which is divisible into two regions; the part of the tube which leads to the exterior is of less calibre and has generally a glittering appearance; this region serves as a duct for the glandular secretion of the distal region; it is lined by a single layer of

non-glandular epithelium and has thick muscular walls; it is these which give the 'nacreous' appearance already referred to; the glandular part of the tube is of greater calibre, and has an opaque white colour, and a rough exterior contrasting with the smooth external walls of the proximal part of the tube. This glandular section of the tube consists of two distinct layers of cells. The innermost coat is formed of a layer of not very deep columnar cells, often loaded with granules; below these are several layers, forming a stratum of considerable thickness, of pear-shaped cells with long processes, which penetrate between the columnar cells and therefore abut upon the lumen, being thus in a position to pour their contents directly into the lumen; the entire structure of the lining epithelium is in fact very suggestive of that of the clitellum; there is the same specialization of its epithelium into two sorts of cells. Outside the epithelium is the peritoneal membrane. This kind of gland is found not only in the genus *Acanthodrilus*, but also in very nearly all the members of the family Acanthodrilidae; it also occurs in such Cryptodrilidae as have a tubular gland of a similar form to that of the Acanthodrilidae, with a few exceptions to be referred to, and finally in a few Perichaetidae. There are hardly even differencies of the minutest character which distinguish the gland in these various types; sometimes the innermost epithelium is more plainly columnar and not so glandular as has been described; but this is very possibly merely a matter of more or less activity in the secreting processes. *Ocnerodrilus* (including a few allied genera which I group together near this) and *Kerria* are the only exceptions, among the Megascolicidae which have a gland of a tubular form, to the description just given; in these genera the difference is in the fact that the lining of the entire tube is formed by a single layer of cells only.

The second form of the spermiducal gland seen in the Megascolicidae characterizes the Perichaetidae and is to be found in a large number of Cryptodrilidae; it occurs only in one Acanthodrilid. Here we have first of all the same differentiation of the gland into a glandular and a non-glandular portion; the external duct is the non-glandular part and its length varies much in different species; certain species of *Perichaeta*, for example, are characterized by this duct being curved into a horseshoe-shape, and diminishing in calibre towards its external aperture; in others, on the contrary, it is short and straight; in none is it absent; it is, as in the case of the gland of the first kind, muscular, with a lining of columnar cells. In these worms the glandular part does not form a comparatively narrow tube of equal calibre throughout; it has the appearance of a racemose gland much divided up into lobules; the lobulation is sometimes so pronounced as to produce a very loose texture of the gland; sometimes the organ is more compact; it is also sometimes larger and some-

times smaller; in *Perichaeta taprobanae*, for example, the spermiducal gland is so small as to be entirely contained within one segment; in other species of *Perichaeta* it extends through a considerable number of segments. The peculiar appearance of the gland is produced by the branching of its lumen; the tubes are lined by low columnar epithelium which does not appear to be ever markedly glandular in character; attached to the tubes are groups of pear-shaped cells massed into bundles, whose fine processes seem to open into the lumen between the non-glandular cells which line it. It is this division of the lumen coupled with the grouping of the glandular pear-shaped cells that gives its peculiar appearance to the spermiducal gland in the Perichaetidae, &c. The whole organ is covered with a fine covering of peritoneum. It will be evident from the figures illustrating the minute structure of the glands (woodcut, fig. 31) that there is no essential difference between this type and the tubular; the difference lies in the fact that in the Perichaetidae the single tube has become branched and the glandular lining has become grouped instead of remaining a continuous layer; we find that genera very nearly allied in other particulars differ as to whether they possess a tubular or racemose spermiducal gland; besides, as I have pointed out, there are among the Perichaetidae glands which seem to be intermediate between the two extremes; the branching is much reduced and as a consequence the breaking up of the glandular cells into groups is not so marked.

In the case of both kinds of glands the relations of the sperm-duct are peculiar; it never opens into the glandular part. As a rule the opening is into the muscular duct just at its commencement; this rule has apparently no exceptions in the Perichaetidae (see, however, the remarks upon *Perichaeta ceylonica*, below); it is, however, not so common among those genera which have the tubular variety of the gland; in *Pontodrilus* the sperm-duct has these relations; but in no member of the family Acanthodrilidae has the sperm-duct any direct connexion with the terminal gland at all. In every species it even opens on to a segment distinct from that which bears the orifice of the these; between this extreme and the other there are various intermediate stages; thus in *Microscolex novae-zelandiae* the sperm-ducts open into the spermiducal gland just before the latter opens on to the exterior; in *Typhaeus* the orifices are separate but are situated upon the same segment. There are as a rule but a single pair of glands in the Megascolicidae; but exceptions are known; thus with the exception of *Acanthodrilus monocystis* the Acanthodrilidae have always two pairs opening on to the seventeenth and eighteenth segments; two pairs also characterize the genus *Gordiodrilus*. In the latter case they are in consecutive segments; a unique disposition of the glands is afforded in the aberrant species of *Perichaeta*—*P. ceylonica;* there are here two pairs, which are in the same segment

upon which presumably the sperm-ducts open (the eighteenth); the two glands of each side are, however, not similar to each other; one is of the tubular variety, the other like that of other Perichaetidae, i.e. 'racemose.' I was unable in examining this species to discover with which, if either, of the glands the sperm-duct was connected.

Developmentally it might appear that the glandular part of the spermiducal gland is distinct from the duct; I have occasionally observed in immature Perichaetidae the duct alone present; and there are several species (*Perichaeta masakatae*, &c.) in which the glandular appendix never seems to put in an appearance.

The Eudrilidae have a characteristic spermiducal gland. It is superficially like that of the Acanthodrilidae but really differs in a number of peculiarities, which together form one of the principal reasons for regarding the Eudrilidae as so distinct a family of Terricolae, and for removing it from the neighbourhood of the Cryptodrilidae. The gland has the same sausage-like form as in the Acanthodrilidae, but has almost always a nacreous glitter owing to its thick muscular coat. The main differences which distinguish the organ of the Eudrilidae from that of all Megascolicidae are:—

(1) The usually thick muscular layer;

(2) The opening of the sperm-ducts into the glandular part;

(3) The presence of a terminal muscular sac (bulbus).

As a general rule the glands in the Eudrilidae are distinguishable, as they are in *Acanthodrilus*, &c., into a thicker glandular portion and a thinner duct, which is lined by a single layer of non-glandular cells.

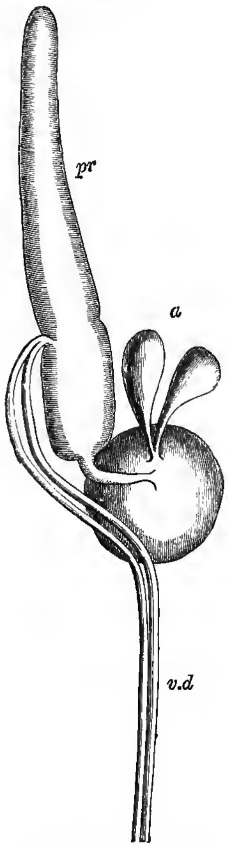
This is particularly well marked in the genus *Eudrilus* itself, where it has been figured by PERRIER and by myself (see woodcut, fig. 30).

In *Eudrilus* the muscular duct is very slender indeed as compared with the glandular tube from which it arises.

In a few other cases, however, there is no such abrupt transition. In *Nemertodrilus*, for example, the gland gradually dwindles towards the extremity which bears the external pore; at the same time there is an increase, though a slight one, in the thickness of the muscular coat; and the lining epithelium becomes one layer. In *Heliodrilus* there is the same absence of any pronounced demarcation between the two sections of the tube, and the glandular lining becomes gradually one cell thick; it retains, however, its glandular character, being formed of large oval cells between which are narrow packing cells; but these disappear just before the opening into the terminal sac.

Eudrilus and *Libyodrilus* are among the genera whose spermiducal glands are furnished with very thick muscular walls; the fibres are arranged in two layers; the outermost, which is the thinnest, consists of longitudinally running fibres; it is these which give the nacreous appearance to the organ; inside the longitudinal is a thicker layer of circular fibres. In *Nemertodrilus* the muscular layer is greatly reduced, but it still consists of the two layers of fibres.

Fig. 30.



EUDRILUS. MALE EFFERENT ORGANS.

v. d. Sperm-ducts. *pr.* Spermiducal gland. *a.* Appendices of terminal muscular sac.

The position of the opening of the sperm-ducts into the glands also varies considerably in different genera; they never, however, open either independently of them or into the terminal bulbus. The apparent opening is nearly always different from the real opening. For instance in *Eudrilus* (cf. woodcut, fig. 30) the two vasa deferentia pierce the walls at a point which is roughly half-way along the gland; microscopic sections, however, show that the tubes run side by side between the muscular and epithelial walls of the gland to a point much nearer to its blind extremity, before opening into the lumen. In *Libyodrilus* the same thing occurs and the actual orifice is near to the very summit. *Nemertodrilus* occupies the opposite extreme in the series. The sperm-ducts here open into the glands nearer to the external pore.

The third character of the spermiducal gland in these worms is also subject to some variation. The terminal bulbus is larger or smaller according to the genus. It is very conspicuous in *Eudrilus* and in *Pareudrilus*. In the former of these two genera it is a rounded sac which appears on dissection like a hemispherical thickening of the body-wall. From its internal walls arise two processes which, together with the peculiar U-shaped gland connected with one of them, will be referred to under the description of the penis of the Oligochaeta.

At the opposite extreme perhaps is *Heliodrilus,* where the bulbus is reduced in size to be merely a slight depression of the external skin into which both the glands open. This terminal sac is protrusible and is generally found more or less protruded in individuals killed with alcohol.

Finally, it should be mentioned that in *Eudriloides brunneus*, at any rate, tracts of epithelium in the glands are ciliated.

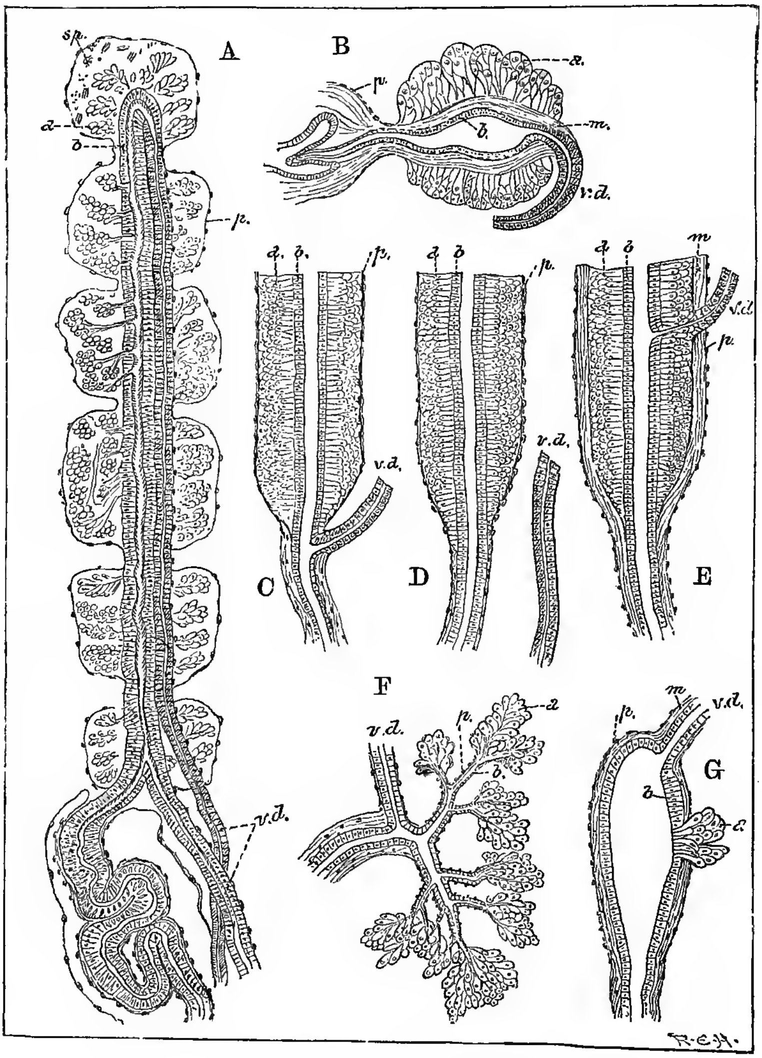
I select *Kynotus michaelsenii* as the type of the Geoscolicidae, as it has been very carefully described by Rosa, though unfortunately his description is unaccompanied by any illustrations.

The terminal apparatus of the male efferent ducts in this Annelid consist on each side of the body of a long oval muscular sac extending through four segments; posteriorly and externally a long tube arises from this which reaches back through another seven segments; the terminal sac is attached to the parietes not only by its own walls, but by a moderately long muscular slip. The terminal sac has very thick walls, which as a consequence reduce the extent of the lumen; its interior is divided by an incomplete septum into two chambers; the upper of the two chambers is furnished with a shield-shaped thickening of the internal wall, on to which opens the glandular appendix to be presently described. The epithelium lining the ventral surface of the two chambers is like the external epidermis, but has rather more numerous glandular cells; the dorsal chamber, on the other hand, is lined by a tall columnar epithelium without glandular cells like those of the lower chamber, but with glandular cells staining deeply with carmine; the entire sac has a chitinous lining. The glandular appendix already spoken of opens on to the shield-shaped projection of the upper chamber; the canal which there opens has the same minute structure as that of the sac into which it opens; this becomes further back a tube lined with two layers of epithelium as in *Acanthodrilus*, &c., ensheathed in a common peritoneal coat which does not follow the windings of the contained tube. The sperm-ducts penetrate the terminal sac near to its external orifice and pass along the thickness of its wall, finally opening into the lumen of the glandular appendix where it retains the non-glandular character of the terminal sac. Rosa considers that the organ in the Geoscolicidae is not the homologue of that of other Oligochaeta and terms it 'Pseudo-prostate.'

It does not, however, appear to me to be possible to draw this hard and fast line between the Geoscolicidae and the Megascolicidae that Rosa wishes to draw; in the first place, as I have attempted to show, the Eudrilidae seem to agree more nearly with the Geoscolicidae than with the Megascolicidae; in both of them the essential difference is in the presence of a muscular terminal sac into which the spermiducal gland proper or the glands in the case of most Eudrilidae open. Rosa has, I think, overlooked the fact that in the genus *Perichaeta* something of the same kind also exists. In the systematic part of the present work I have laid some little stress as a specific character upon the fact that in some species the narrow muscular duct of the gland does not communicate directly with the exterior, but opens into the interior of a variously-sized sac; this latter may be of large size, as in

Perichaeta indica; or it may be almost absent, as in *Perichaeta hesperidum*; probably, though I have no positive data upon the subject, it is extrusible and

Fig. 31.



SPHERMIDUCAL GLANDS OF VARIOUS OLIGOCHAETA.

A. *Sutroa*. B. *Moniligaster*. C. *Pontodrilus*. D. *Acanthodrilus*. E. *Eudrilus*. F. *Perichaeta*. G. *Tubifex*. *p*. Peritoneum. *v. d.* Vas deferens. *b*. Epithelial lining of spermiducal gland. *a*. Glandular cells. *m*. Muscular layer *sp*. Spermatozoa.

performs the function of a penis. In any case, whatever its function may be, it seems to be fairly comparable to the terminal muscular sac of the Eudrilidae and

the Geoscolicidae. No other genus of Megascolicidae, so far as I am aware, shows the same terminal sac; this fact is not without its importance; it is so far an indication that the Perichaetidae, having preserved this structure, are nearer to the Geoscolicidae and the Eudrilidae in which it is better developed than any other sub-family of the Megascolicidae. I use this as an argument in favour of the low position of the Perichaetidae in the series (see below).

Another reason which led Rosa to dissociate the 'pseudo-prostate' of the Geoscolicidae from the 'prostate' of other earthworms was the existence of special retractor muscles in the former. These, however, are not absent from the latter. In the genus *Octochaetus*, for example, there are numerous bands of muscular tissue which are inserted on to the body-wall in the immediate neighbourhood of the male pores. A better example still is afforded by two species of *Eudriloides* (see Beddard **84**), where there is a complex system of retractor and protractor muscles attached to the ducts of the glands themselves.

It may be useful to tabulate the principal varieties of the spermiducal glands which are illustrated in the accompanying diagram (woodcut, fig. 31).

A. Glands with a double lining of cells.

a. Tubular, e.g. *Acanthodrilus*.

b. Racemose glands in which lumen has become branched and outer glandular layer of cells disposed in discrete tufts instead of forming a continuous layer.

e.g. *Perichaeta*.

A′. Tubular glands with a double lining of cells covered externally by a layer of muscles; terminal extremity modified into a copulatory apparatus.

e.g. *Eudrilus*, *Kynotus*.

B. *a*. Spherical or more elongated glands with two layers of cells separated by a muscular layer.

e.g. *Rhynchelmis*, *Moniligaster*, *Branchiura*.

b. Outer layer of cells grouped into separate masses.

e.g. *Sutroa*, *Telmatodrilus*, *Tubifex* (one mass only present).

C. Tubular glands with single lining of cells.

e.g. *Ocnerodrilus*, *Kerria*.

The structure which is here termed spermiducal gland has been called 'prostate' and 'atrium' by several; the distinction of terms implies a difference in homology between the different appendages of the sperm-duct, which are by all called 'atrium' in the aquatic Oligochaeta. Does this difference really exist, or are all the glandular sacs at the end of the sperm-duct homologous throughout the Oligochaeta? I myself

incline to the latter view, and will here state my reasons for so doing. The first reason which leads me to this opinion is entirely *a priori*; this is, however, in the present case a more powerful reason than it might be supposed to be, and than it would be perhaps in some other cases. The Oligochaeta so evidently form a single, well-definable group that the structures of the terrestrial forms may be confidently expected to be represented in the aquatic genera; at any rate we know of no structures which are peculiar to one or the other except those now in question.

No one, I imagine, will doubt that all the structures called 'atrium' in the aquatic genera are homologous with one another. With inconsiderable exceptions these 'atria' receive the sperm-ducts; they have even been (erroneously) spoken of as an 'enlarged part of the sperm-duct.' In the Eudrilidae and in those Geoscolicidae, where they exist, the glandular tubes at the male pore also receive the sperm-ducts; in *Eudrilus* itself, for example, the sperm-ducts open into the middle of the glandular tube; it can hardly be doubted that in this case we are dealing with a structure that does accurately correspond to the 'atrium' of the lower Oligochaeta. In the Acanthodrilidae, for instance, another arrangement occurs: here the structures which I have termed spermiducal glands open quite independently of the sperm-ducts, even on to a different segment; and yet the histology of the gland is in its main features quite like that of the Eudrilidae. The link between the two is afforded by a series of genera; in *Pontodrilus* the gland is not independent of the sperm-duct; but the sperm-duct opens into the muscular duct and not, as in the Eudrilidae, into the glandular region; in *Typhaeus* and in *Microscolex* the sperm-duct only communicates with the gland just before the opening of the latter on to the exterior; in *Gordiodrilus* the external pore of the gland is perfectly distinct from the pore of the sperm-duct but is placed upon the same segment; there are thus various intermediate conditions between the extremes. It can hardly be doubted that these latter genera possess organs which are homologous in spite of the rather different relation of the sperm-duct to them: in the Eudrilidae themselves the position of the opening of the sperm-duct into the gland varies in different genera. To insist upon a difference between the spermiducal gland of the Eudrilidae and that of the Acanthodrilidae, because in one there is a direct connexion between it and the sperm-duct, and in the other there is not, seems to me from a consideration of the intermediate stages to be absurd; and if we apply this argument to the aquatic Oligochaeta the absurdity is even more apparent. In the genus *Branchiura* which I have recently described, the 'atrium' is appended as a diverticulum to the sperm-duct; the two open in common, but the 'atrium' does not receive the sperm-duct at its summit, but at the point where it passes into a muscular duct which leads to

the exterior; in spite of this difference, who could deny that the structure which I have called 'atrium' in *Branchiura* is the exact homologue of the 'atrium' in other Tubificidae? To suppose that two structures so similar and yet morphologically different could exist in the genera of a limited family like that of the Tubificidae is to suppose too much, and to go counter to plain facts. Still, if BENHAM was right in calling the gland appended to the male duct in *Pontodrilus* 'prostate,' and the similar gland in *Eudrilus* 'atrium,' it will be necessary to explain how it is that structures which are of different morphological import have come to possess an almost identical structure. And if the term 'prostate' is retained 'for those glands which either pour their secretion into the sperm-duct or open independently to the exterior,' then the structure which I have called 'atrium' in *Branchiura* cannot be the homologue of the 'atrium' in other Tubificidae and Lumbriculidae. This appears to me the *reductio ad absurdum*, and to dispose of the necessity for further argument. There has been, however, some little confusion as to the meaning to be attached to the term 'prostate,' independently of the facts already referred to. I have called the glandular investment of the 'atrium' in the Lumbriculidae 'prostate,' and compared this glandular investment to the 'Cementdrüsen' of *Tubifex*: it may be that I have, as BENHAM suggested, compared together structures which cannot be compared, since they are respectively epiblastic and mesoblastic in origin; in any case I did not seriously make that comparison after deliberation; I am now inclined to think that that comparison is after all the right one, provided only that embryology confirms it. The glandular investment of the 'atrium' in the Lumbriculidae does not appear to be peritoneal; we cannot, however, be certain, though it is so exactly like the glandular investment of the 'atrium' in *Moniligaster* which is probably not peritoneal. I have seen sections through the 'atrium' of *Moniligaster* in which the thick layer of cells investing it externally is covered by a thin layer of what is undoubted peritoneum; and there is no doubt that the layer of cells in question opens by prolongations of the cells into the lumen of the gland—a state of affairs which is not suggestive of its being in reality peritoneum, as I at first believed it to be. VEJDOVSKY, too, has figured a similar prolongation of the cells of the glandular coating of the 'atrium' in *Rhynchelmis* to join the lumen[1]; the same thing undoubtedly exists in *Sutroa*; in all these cases, therefore, I believe that we have to do with a second layer of epithelium of epiblastic origin; the absence, if it be ultimately proved, of a peritoneal layer in certain Lumbriculidae, and in some species of *Moniligaster* does not appear to be a matter of the greatest consequence, since in

[1] Moreover, BENHAM has described a delicate membrane surrounding the pear-shaped cells which is probably the coelomic epithelium.

the 'atrium' of *Tubifex* the peritoneum is absent from the 'Cementdrüse,' which has been shown by VEJDOVSKY to be an outgrowth of the lining membrane. I would therefore compare the 'Cementdrüse' of *Tubifex* to a portion of the glandular investment of the atrium in such forms as the Lumbriculidae[1]; this view of the relations of the different parts brings matters into a far more satisfactory condition; and it helps us also to get a clearer insight into the meaning of the apparently great difference between the spermiducal gland of the Perichaetidae and the Acanthodrilidae—in fact to compare more readily the 'lobate' with the 'tubular' form; in the class of gland which I have termed 'lobate' the lumen is much branched, and the outer layer of glandular pear-shaped cells, instead of forming as it does in the Acanthodrilidae, and in other genera which have the tubular form, a continuous covering is broken up into masses of cells; now we get something very much like this in the genus *Telmatodrilus* among the Tubificidae, and in *Sutroa* among the Lumbriculidae; but in neither of these genera is there any corresponding branching of the lumen of the gland itself. Those Perichaetidae in which the gland is the most compact, in which the branching is not so conspicuous, show the earlier stages in the conversion of a tubular into a lobate gland—for example, *Megascolex newcombei*, while *Diplocardia* is an almost ideal intermediate form; there is in fact no difficulty in getting the one form of spermiducal gland out of the other.

I have now to consider certain points in the histology of the glands which might seem to militate against a comparison between those of the aquatic and the terrestrial genera. In the former the cavity is lined by a single layer of cells often ciliated, which are separated by a layer of muscles from the outer layer of cells which have been spoken of by some as 'prostates.' In the terrestrial Oligochaeta, on the other hand, with a tubular spermiducal gland, the lining membrane is with a few exceptions always composed of two distinct layers; its resemblance in fact to the clitellum has been often insisted upon; I was inclined at one time to contrast these two forms, and to connect the resemblance of the spermiducal gland of the higher Oligochaeta with the clitellum with its origin from the clitellar region of the body: I do not now think that the difference is a real one; in such genera as *Moniligaster* it seems to me merely that the inner epithelial layer has been removed a little way from the other layer, so that a layer of muscle has come to intervene; just as certain glandular cells, undoubtedly of epidermic origin, have come to be imbedded in the musculature of the body-wall; the two cases seem to me to be perfectly parallel. This view of the matter has been put forward by ROSA

[1] These views with regard to the homologies of differently named structures are now those of BENHAM (25) as well as of myself (80).

(**4**, p. 385) with regard to *Desmogaster:* he pointed out that in the worm the outer layer of glandular cells were imbedded in a stratum of muscle, and that the atrium was so far intermediate between that of *Moniligaster* and *Acanthodrilus*, &c.; the muscles had not quite got to divide the two epithelial layers clearly from each other. Still, of course, this does not take away from the closer resemblance of the gland of *Moniligaster* to that of the Lumbriculidae than to that of the terrestrial earthworms. The occasional though rare ciliation of the lining epithelium in Eudrilidae removes all the differences that separate the spermiducal gland of the higher from that of the lower Oligochaeta. It will be seen therefore that the 'prostate' of *Perichaeta* may be safely compared with the 'Cementdrüse' of *Tubifex* without doing any harm; but that the insistance upon this homology must not be carried so far as to obscure the other obvious relations between the spermiducal glands of different forms.

A question which now requires consideration is the origin of the spermiducal glands; are they to be regarded simply as dilatations on the sperm-duct or as separate structures which have come to have a relation to the sperm-ducts? I incline to the latter view. The chief reason which leads me to take up this position is the existence of supplementary glands which have no relation to the sperm-ducts; in *Dichogaster damonis* the two segments following that upon which the sperm-ducts open are each furnished with a pair of tubular glands exactly like the spermiducal glands in structure, but rather smaller: it is also remarkable to find that these two pairs of glands open on to the exterior in exactly the same position as those of the seventeenth segment, and that the ventral setae of their segments, as of the seventeenth, are missing; nothing in fact is wanting to complete their likeness to spermiducal glands, except that they have no direct relation to the sperm-ducts. The occasional presence of two pairs of glands to only a single pair of male pores, as we find in *Acanthodrilus, Gordiodrilus*, and *Perichaeta ceylonica*, is not so remarkable, for in all these worms there are two pairs of distinct sperm-ducts, although they become one at the external pore. This view of the origin of the glands is the one held by Rosa; in a paper upon the structure of *Kynotus michaelsenii* this author refers the spermiducal glands to the same category as certain glands found in that species in the segment following, and showing exactly the same minute structure. These glands are accompanied by penial setae. Rosa, it should be stated, is not of opinion that this view can be applied to the glands of other earth-worms; he is only considering the Geoscolicidae, which according to him have 'pseudo-prostates,' not comparable to the apparently similar glands in the Oligochaeta generally; this opinion of Rosa's is not one that commends itself to me, and I have

already attempted to show that the spermiducal glands in the Geoscolicidae are like those of the Eudrilidae more than any other group. In *Microcheta benhami*, also, there are a series of quite analogous glands which are referred by Rosa to the same category as the spermiducal gland; he also holds this view with respect to the posterior glands of *Pontoscolex*, *Urobenus*, and *Brachydrilus;* as regards this latter comparison I may point out that the connexion of the glands of *Pontoscolex* with the nephridia is curiously paralleled by the connexion of the spermiducal gland of *Heliodrilus* with the nephridia of its segment; this connexion, however, may not be more than accidental in the latter case. The existence of this relation, especially in *Pontoscolex*, suggests that perhaps Rosa has not gone quite far enough back in seeking for the origin of the glands. It may be that the glands, with which I think with Rosa that the spermiducal glands are homologous, are themselves derived from the nephridia; as we now know that the sperm-ducts are homologous with nephridia, the connexion of the sperm-ducts with the spermiducal glands may be in this case comparable to the connexion of the nephridia of *Pontoscolex* with the posterior glands; this, however, does away with the significance of the connexion between the two in *Heliodrilus*. The glands in *Kynotus* lying behind the spermiducal glands are provided with modified setae, and thus the resemblance to the spermiducal glands, as they usually are, is completed; we must not, perhaps, leave out of consideration the anteriorly situated glands, also provided with modified setae in a few species of *Acanthodrilus* (s. l.), &c.; these are very likely to be placed in the same category. It is possible that the glands which are so often found in the neighbourhood of the male pores and the spermathecal pores in the Perichaetidae should be also referred to the same series; but it may be remembered that these latter have no lumen, and would therefore have to be looked upon as much degenerated. Still their frequently paired arrangement, corresponding to that of spermiducal glands, is an argument to be borne in mind. The spermathecae also suggest the same origin, but I deal with their homologies under the heading 'Spermathecae' (see below).

Closely connected with the last question, and, of course, with the phylogeny of the Oligochaeta, is another question: what is the most primitive form of the spermiducal gland? If we accept their serial homology with the copulatory glands it is evident that those spermiducal glands which are structurally most like the copulatory glands will have to stand at the base of the series. It should be noted in the first place that there seems to be a certain relation between the copulatory glands and the spermiducal glands in those few forms in which they coexist; that is to say, differences in the structure of the copulatory glands are repeated in the spermiducal glands. In *Kynotus* both glands have a muscular covering; in

Acanthodrilus both are without it; so too in *Dichogaster damonis*. The question, therefore, of the origin of the spermiducal glands is bound up with that of the copulatory glands, and must be deferred until we can determine which is the most primitive type of copulatory gland. It seems reasonable to suppose that the copulatory glands were originally modified tracts of the body-wall, which became invaginated and furnished with penial setae for their greater efficiency; the invagination, as it appears to me, might or might not involve the muscular layers of the body-wall; so that very probably both circumstances have occurred, which would account for the correspondence, noted above, between the copulatory and spermiducal glands. In this case the spermiducal glands of the Geoscolicidae might be equally primitive with those of the Megascolicidae. Another point, which has to be taken into consideration, is the relationship of the sperm-duct to the spermiducal gland. The independence of the sperm-duct and the gland is, *ex hypothesi*, a primitive condition. This suggests that the Geoscolicidae, and particularly the Acanthodrilidae, *Perichaeta ceylonica*, and *Dichogaster* are primitive forms. The spermiducal gland of *Moniligaster*, which is characterized by the transference of the gland-cells to the outer side of the muscular layer, seems to be a later stage in the evolution of the organ than that found in the Eudrilidae.

§ 8. *Genital setae.*

In the neighbourhood of the male-pores there are in some Oligochaeta bundles of long modified setae which protrude through the orifices in question; to these structures the name of penial setae was first applied by LANKESTER (**1**). In a very few species there are bundles of quite similar setae developed in the neighbourhood of the spermathecae, and in a few Geoscolicids, again, similar setae are found, not only at the male-pores, but on a greater or less number of segments in their immediate vicinity. HORST has proposed to limit the name penial setae to those setae which occur in the neighbourhood of the male-pores, and to call copulatory setae those which are found in the vicinity of the spermathecae. It is perhaps more convenient to apply the term 'genital setae' to all alike.

These setae are nearly always found associated with glandular structures; in the case of those which protrude through the male-pores, there are, of course, the spermiducal glands with which they are more particularly associated; the sacs which contain them are often or at any rate have the appearance of being, diverticula of the spermiducal glands. The setae which occur in the neighbourhood of the spermathecae have special glands developed in connexion with them, which are described in the section devoted to the spermathecae. The special setae developed

in various Geoscolicidae are nearly or always so accompanied by glands. This obviously suggests some relation between the setae and the glands. It looks as if the long setae had the function of either conveying by capillary attraction the secretion of the glands or opening wider an aperture for the passage of the secretion. It seems likely that that is the function of those setae which are developed in the neighbourhood of the male-pores, perhaps more specially those in which the spermiducal glands and sperm-ducts open by a common pore; they would facilitate the passing of the sperm and the secretion of the spermiducal glands. In the Acanthodrilidae, on the other hand, where the spermiducal glands open at some little distance from the sperm-ducts, the function would seem to be rather that of grappling the integument in the neighbourhood of the spermathecal pores in another individual; here, however, it is possible that the sperm, when liberated from the male-pore may flow along the groove which connects this pore with those of the spermiducal glands, and may at these points mix with the secretion of the spermiducal glands, and be with it conveyed to the spermathecae of the other individual. Genital setae associated with the male-pores only occur in the Megascolicidae, the Eudrilidae, and (rarely) in the Geoscolicidae, Lumbriculides; in fact, they only occur in those families of terrestrial Oligochaeta in which the male-pores are provided with spermiducal glands. They do not, however, often occur in the aquatic families which have also such glands. Though their range of occurrence is thus a wide one, they really are found in comparatively few species; it is unnecessary here to give a list, which can be compiled from an inspection of the systematic part of this work. Naturally, too, the exact shape of the setae differs; but in most cases the extremity is beset with spines, a state of affairs, however, which is by no means universal; in many species of *Acanthodrilus*, for instance, the penial setae are quite smooth throughout.

It is an interesting question as to whether these genital setae are new and special structures, or whether they are to be derived from the ordinary setae of the body which have become modified and converted to a new function. The second alternative is evidently the one which is most likely on *a priori* ground to be true; and, as a matter of fact, I believe it to be the true view of the origin of the setae. It will be noticed in the first place that when such modified setae are present the ordinary setae are wanting; they are present in the immature worms, but drop out when the genital setae make their appearance; and the genital setae as a rule occupy exactly the place of the missing ordinary setae. There are, too, not wanting transitional forms between the ordinary setae of the body and the modified genital setae; I have pointed out in *Octochaetus antarcticus* that the genital setae are much less specialized than in the nearly allied *Octochaetus multiporus*. On the whole,

therefore, it seems reasonable to regard the genital setae as being the modified representatives of the ordinary setae which should occupy their place. But another question requires answering: the bundles of genital setae generally contain more fully developed setae than would usually be present; not, of course, in the genus *Megascolex*, but in such a genus as *Acanthodrilus*. I have suggested that this points to the former perichaetous condition, a number of setae having been retained for the purpose of serving this new function. Though this view has not met with acceptance, there are other considerations which seem to me to favour it. In *Perionyx*, as it appears to me, we have an early stage in the development of the genital setae preserved. In that genus there is (in some species) a row of the more ventrally placed setae, which are modified in structure, being beset with ridges at the distal end and being somewhat larger than the ordinary setae, which are smooth. These setae are sometimes imbedded in a groove into which opens the male-pore on each side; if this groove were withdrawn, so as to convert it into a more strongly marked recess, it would follow that the setae would be crowded together, as is the case with the genital setae of the other genera, and that they would at the same time tend to become longer, in order to be capable of projecting out of the invagination in which they are imbedded. This suggestion is to my mind reinforced by the distribution of genital setae associated with the sperm-duct apertures; they occur in the Mègascolicidae in *bundles;* the setae are numerous, though varying in number. Now it is at least arguable that all the worms belonging to this family are traceable to a form with a complete circle of setae. On the other hand, in the Eudrilidae the penial setae are not in bundles; there is only a single seta so modified on each side of the body; and this family is one in which perhaps the evidence of a descent from some form like *Perichaeta* is least arguable among the terrestrial Oligochaeta. It is true that the Geoscolicidae seem to be opposed to this way of regarding the matter. I am on other grounds disposed to connect them closely with the Eudrilidae, and this view of their affinities undoubtedly affords a way out of the difficulty. As will be seen later, I believe that the aquatic Oligochaeta are not near to the terrestrial; and it will be noticed that in none of these that have paired setae are there *bundles* of genital setae.

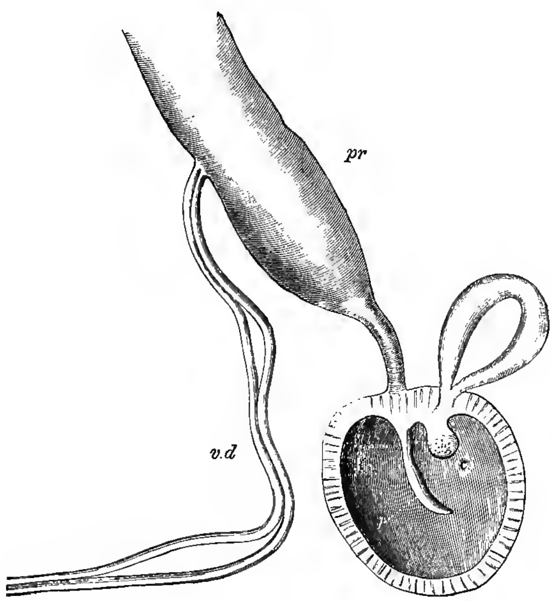
A curious fact has been observed in a few earthworms, for example in *Benhamia annae*, and in other Acanthodrilidae, and that is that the penial setae in a single bundle are of two kinds; there are setae with an extremity marked by the presence of spines, and others in which the extremity is quite smooth; that both kinds of setae are fully mature, that the one kind are not the immature kind of the other, seems to be proved by their being of the same size.

§ 9. *Penis.*

The presence of a copulatory organ, more or less analogous to the vertebrate penis, is not uncommon among the Oligochaeta. These organs may be single or paired, retractile or non-retractile. Sometimes they are directly connected with the male-ducts which open in them or on them; more rarely they have no such close connexion.

In the preceding section, dealing with the spermiducal glands of the Oligochaeta, I have described the terminal part of these glands, which is almost always of a muscular nature; in many worms this part of the tube is partly protrusible, perhaps it is so in most; I have found that it certainly is so in *Perichaeta houlleti*, where a number of specimens killed with alcohol had the terminal part of the muscular ducts of the spermiducal glands everted; I have not noticed the occurrence of this in any allied forms, but it very possibly takes place. In some *Perichaetae* the muscular duct of the spermiducal glands opens into a wide and rather thin-walled terminal chamber, which opens directly on to the exterior; it is here, again, possible that this terminal chamber is protrusible; but I have no facts at hand to prove or disprove the possibility. In most Eudrilidae the two spermiducal glands open into a single or paired terminal copulatory apparatus, which may be fairly termed a penis. This structure, as has already been pointed out, varies much in its development from genus to genus. It is very well developed in *Eudrilus;* in that Annelid the terminal apparatus consists of a widish chamber, opening directly on to the exterior; into this chamber open first the spermiducal gland, and secondly the peculiar horseshoe-shaped 'glands' which are figured in the accompanying woodcut (fig. 32). The spermiducal glands open on to

Fig. 32.



TERMINAL EFFERENT APPARATUS OF EUDRILUS.

pr. Spermiducal gland. *v. d.* Sperm-duct. *p.* Penis, and *c.* Cushion like pad in interior of 'Bursa copulatrix' which has been cut open.

a kind of penis (*p*), which projects into the interior of the terminal chamber. It seems quite reasonable to suppose that the chamber can be everted; in which case the projection which bears the aperture of the spermiducal gland will play the part of a penis.

In all Eudrilids there is something of the same kind, but the details differ; the structures are described under the account of that family. *Moniligaster*—at any rate one species of that genus—has a penis which is a little different, though it agrees in being retractile. The muscular end of the spermiducal gland does not open directly on to the exterior, but into a terminal chamber whose walls are reflected round it; we have, in fact, in this genus, an arrangement which is closely paralleled in the Tubificidae, and not very remote from the arrangement met with in *Eudrilus*.

In the genera *Stylodrilus*, *Alluroides*, *Stuhlmannia*, *Alvania*, *Hyperiodrilus*, and *Siphonogaster*, there are penes of quite a different nature. In all these worms, which, it will be observed, belong to three different families, the penis or penes are non-retractile; they are processes of the body-wall, which may or may not have an intimate relation to the aperture of the sperm-ducts. It will be necessary to describe them one by one.

Of *Stylodrilus* the penis has been described by Vejdovsky and Benham. In *Stylodrilus gabretae* the two penes are figured by the former as longish, hollow processes of the body, whose walls are cellular; they communicate directly with the spermiducal glands, of which they appear to be merely a continuation, but they are not retractile.

The recently-described genus *Alluroides*, from East Africa, has a pair of penes which are clearly outgrowths of the body-wall; they are placed, moreover, above the opening of the male-ducts; they are peculiar in form, inasmuch as they are rather thick processes, hardly tapering at the extremity, which, in the preserved examples of the worm, are folded in an irregular fashion; the organ, though not retractile, seems to be probably contractile, as the shape which it assumed in the preserved worms was hardly such as to ensure its usefulness as an organ for transferring sperm to the spermathecae.

The penis of *Stuhlmannia* has been figured, as regards its naked eye characters, by Michaelsen (6). Its varying position is not a little remarkable; but it always lies somewhere near to the male-pore, and is at any rate connected with that pore by a groove in the skin. In transverse sections of the body-wall (see Plate IV), the penis is seen to be asymmetrical in structure; it is roughly conical in outline; one side is covered by a thick glandular epithelium; the other side is covered by an

unmodified epithelium, which is like the ordinary epidermis. The interior of the organ is occupied by a quantity of laxly-arranged muscular tissue. In connexion with the penis there is developed a long sausage-shaped body of a nacreous aspect; this gland is covered by very thick muscular walls, and is lined by not particularly glandular epithelium. It narrows towards the external pore, which is situated on that side of the penis which is covered by thick epidermis. The penis does not always appear to be developed; I have examined a considerable number of sexually mature individuals in which I could find no traces of a penis. The penis here seems to be not much more than an outpushing of a part of the body-wall; the muscular sac connected with it may be the equivalent of the bursa copulatrix in *Teleudrilus*, divorced from its connexion with the rest of the terminal male efferent apparatus. In the genus *Hyperiodrilus* there are a pair of penes, which are connected by grooves with the male-pore; these penes are, as in *Stuhlmannia*, variable in position; they sometimes lie on the same segment as that which bears the male-pore, sometimes they are a segment in front, and in the latter case they are usually at least asymmetrical. In my description of *Hyperiodrilus* I described these structures as papillae; I think that they are more comparable with the penis of *Stuhlmannia*, with which, indeed, I compared them. There are no details as to the minute structure. The penis of *Siphonogaster* is described under the genus.

§ 10. *Spermathecae.*

The spermathecae are very characteristic organs of the Oligochaeta; it is only in a very few forms among those whose anatomy is well known that they are absent. They seem to be entirely unrepresented in the following:—

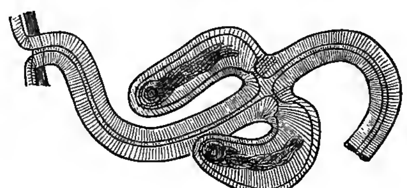
Criodrilus lacuum.	*Lumbricus eiseni.*
Perichaeta acystis.	*Allolobophora constricta.*
Geoscolex maximus.	*Allolobophora samarigera.*
Anteus gigas.	*Bothrioneuron vejdovskyanum.*
Siphonogaster millsoni.	*Bothrioneuron americanum.*

All the remaining Oligochaeta (with possibly a few more exceptions) have a varying number of pairs of these organs. Recent researches have brought to light the fact that the sperm-holding organs of the Oligochaeta are of two kinds, morphologically distinct. More generally the spermathecae are sacs which are most probably—though the actual origin has been traced in but few types—derivatives of the epidermis. In the family Eudrilidae these spermathecae are either more or less rudimentary or completely absent, their place being taken by sacs which are derived from the septa of the neighbouring segments and whose cavity is thus

coelomic. These two sets of organs of different origin, but of similar function, will be discussed here separately.

(1) *Spermathecae derived from invaginations of epidermis.*—This is the prevalent form of the organ. Spermathecae of this kind are spherical, oval, or more elongated pouches, with or without diverticula, varying in number and position, opening on to the exterior by a more or less pronounced duct and, except in rare cases, ending blindly at the other extremity. Like other organs developed from the epidermis, the spermathecae do not, for the most part, show any ciliation; in rare cases, which, however, may possibly be commoner than is thought, a ciliation does occur; it has been described, for example, in *Tubifex;* and I have described a ciliation of the spermatheca of *Acanthodrilus rosae* (**43**). Cilia seem to be out of place in a sac communicating with the exterior and serving for the storage of sperm.

Fig. 32.



SPERMATHECA OF MESENCHYTRAEUS BEUMERI.

(After Michaelsen.)

The upper extremity is cut off where the spermatheca opens into the gut. The two diverticula contain sperm.

MICHAELSEN described, some years since, the remarkable fact that in *Enchytraeus möbii* the spermathecae instead of ending blindly opened into the gut; he was able to trace the bundles of spermatozoa from the spermathecae into the lumen of the gut by staining methods; he has since shown that many, indeed most, Enchytraeidae show the same remarkable connexion between the interior of the spermathecae and the lumen of the gut; I can entirely confirm this discovery for several species belonging to the family Enchytraeidae; sometimes the aperture is at the tip of the spermatheca, at other times on the side. More recently I have pointed out that in the genus *Sutroa* there is the same communication between the two organs; and in all probability *Rhynchelmis* will be proved to agree with *Sutroa.* On a later page I shall have to direct attention to the fact that in *Paradrilus*, where the spermathecae are of the second type of these organs, the same thing occurs; it seems, therefore, to be of functional, rather than morphological, importance. Possibly, as has been suggested by MICHAELSEN, this device ensures the getting rid of superfluous spermatozoa, which might otherwise decay and cause injury to the animal by so doing. On the other hand, a second suggestion might be made, which I give for what it may be worth; WHITMAN has recently made the very interesting discovery that impregnation among the Hirudinea may take place through the epidermis; the spermatozoa apparently, in some cases, force their way through the body-wall and fertilize the ova lying within

the body; he suggests that the same may be the case with the Oligochaeta, in many of which the spermatophores seem to be attached to the outside of the body 'anywhere.' It is just possible that spermatozoa may be conveyed a short distance by the alimentary tract and then make their way out to fertilize the ova. In connexion with the above suggestion it may be noted that VEJDOVSKY could not find in a single case even one spermatozoon in the albumen of the cocoon.

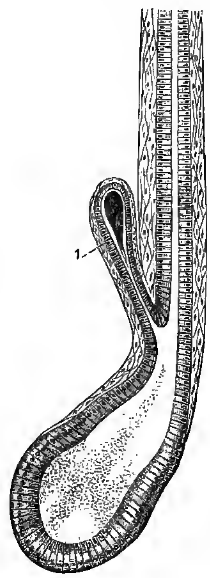
The above, however, are rare exceptions to the rule that the spermathecae end blindly in the body-cavity. Among the lower Oligochaeta the organs are generally simple pouches without any diverticula; this is so with the Naidomorpha, the Tubificidae, the Lumbriculidae (except *Rhynchelmis* and *Sutroa*), the Phreoryctidae, and the Moniligastridae. Of the aquatic families the Enchytraeidae alone are usually provided with one or more diverticula; the Lumbriculidae are sometimes provided with diverticula—at least *Sutroa* and *Rhynchelmis* are. The higher Oligochaeta, as a rule, have diverticula; this is the case with the families Perichaetidae (a few exceptions), the Acanthodrilidae (also a few exceptions), the Cryptodrilidae (like the others with a few exceptions). The members of the two families Lumbricidae and Geoscolicidae never possess diverticula.

In the family Eudrilidae there are sometimes spermathecae met with; this statement requires qualification to the extent that spermathecae of the type hitherto considered are sometimes present; the majority of the members of that family have spermathecae of a totally different morphological nature, which are described further on. In those cases where spermathecae derivable from epidermic invaginations (probably, for that fact has not been actually proved) occur, these organs are invariably placed far back in the body, the most forward position being seen in the genus *Heliodrilus*, where they are in the tenth segment; the spermathecae are always unpaired and of course open in the median ventral line. They never possess diverticula, and, indeed, appear to be of limited functional importance, as they have not been observed to contain sperm; in *Heliodrilus*, however, the spermatheca is of great length, extending from its external aperture on the tenth segment as far back as the fifteenth.

When diverticula are present, they are of varying degrees of importance; they also vary in number; in the Perichaetidae there is, as a rule, only one diverticulum, which is often of considerable size; two diverticula are found in various Acanthodrilidae and Cryptodrilidae; in *Octochaetus multiporus* there is a circle of small diverticula round the external aperture of the spermatheca. There are two facts of interest to be noted in connexion with the diverticula; in the first place they are of slightly different structure from the pouch of which they are appendages; secondly,

they contain, in mature worms, spermatozoa, absent in the pouches themselves (see accompanying woodcut, fig. 34). *Acanthodrilus dissimilis* may be used to illustrate the first point; in this species there are two diverticula to each spermatheca; they are lined with an epithelium which is largely converted into irregular masses of an amorphous appearance, in which are imbedded bundles of spermatozoa; it looks very much as if the lining epithelium had become converted into a substance, the function of which was to hold firmly the spermatozoa until they were transferred to another individual. In other worms the diverticula are lined with a low quadrangular epithelium differing so far from the tall columnar cells which line the pouch; this is the case with *Perichaeta* and other genera. In no case have I observed an absolute similarity between the epithelium of the pouch and of the diverticulum; in no case have I found any spermatozoa in the pouch itself; they were always in the diverticula. Rosa has indicated an exception to this; no doubt it may easily happen accidentally that the sperm goes astray and finds its way into the wrong cavity; the very fact that Rosa thought it worth while to mention the exception shows how widely prevalent is the rule. It is very curious that the spermatozoa should choose the narrow path leading to the interior of the spermathecal appendix rather than the broad and, one would have thought, easier road into the spermathecal pouch. It has been suggested by Benham that when the male apparatus is everted in copulation (this can at any rate take place in some worms) and pushed into the spermatheca, the everted portion blocks the route to the spermatheca, but leaves free the aperture of the sperm-duct which is directed into the appendix. The question of the function of the various parts of the spermathecal apparatus will be discussed later (see below).

Fig. 34.



LONGITUDINAL SECTION OF THE SPERMATHECA OF A BENHAMIA.

(After Horst.)

1. Diverticulum containing sperm.

Apart from the presence or absence of diverticula, the number and position of the spermathecae vary in different families of the Oligochaeta. They are sometimes further forward, and sometimes more posterior in situation. The most anterior position in which they occur is seen in the genus *Aeolosoma;* here the first pair of spermathecae may be as far forward as segment iii. In the Lumbriculidae and in some Geoscolicidae they are as far back as they are ever found—viz. in segments xiv–xvi.

The following table shows all the different segments which may be occupied by the spermathecae in the Oligochaeta:—

Segment iii	*Aeolosoma.*
Segment iv	*Aeolosoma.*
Segment v	*Perichaeta.*
Segment vi	*Perichaeta.*
Segment vii	*Perichaeta.*
Segment viii	*Perichaeta.*
Segment ix	*Perichaeta.*
Segment x	*Allolobophora.*
Segment xi	*Allolobophora.*
Segment xii . . .	*Allolobophora.*
Segment xiii	*Microchaeta.*
Segment xiv	*Microchaeta.*
Segment xv	*Kynotus.*
Segment xvi	*Microchaeta.*

As a rule there is a certain relation between the position of these organs and that of the testes. Thus in *Aeolosoma*, where the testes are in the fifth segment, the spermathecae commence in the third; in the Naidomorpha they lie in the same segment as the testes, viz. the fifth; this is also the case with the Tubificidae; both testes and spermathecae are in the tenth. In earthworms the spermathecae generally lie in front of the testes; but in the Lumbricidae they are often in the same segments. No very definite relation between the position of the spermathecae and that of any other organ can be traced; any attempt to trace such a relation is rendered difficult by numerous exceptions. It is only in certain Lumbriculidae and in *Phreodrilus* that the spermathecae are behind all the reproductive organs. They appear never to be placed behind the clitellum.

As a rule each segment of those which contain them has only one pair of spermathecae; among the Geoscolicidae, however, a very large number of spermathecae sometimes occur in a single segment; thus in *Kynotus madagascariensis* there are as many as fourteen pairs in one segment. *Perichaeta sangirensis*, and a few allied species, *Allolobophora savignyi*, are the only worms not belonging to the family Geoscolicidae in which numerous spermathecae take the place of the more usual pair. This great increase in numbers is accompanied by a reduction in size, more marked in the Geoscolicidae than in the *Perichaeta*. When the spermathecae are paired, the number of pairs varies from one to seven. One is the usual number in the lower forms, and is

perhaps an indication of the simplification of these genera; we find only a single pair of spermathecae in the Tubificidae, the Enchytraeidae (with just one exception), the Naidomorpha, most of the Lumbriculidae; *Aeolosoma*, the lowest of all the Oligochaeta, may have as many as three pairs in segments iii, iv, v. Among the higher Oligochaeta the largest number of pairs, seven, occurs in *Allolobophora complanata;* a few Perichaetidae have five pairs, but on the whole two pairs is the prevailing number among earthworms; the numerous exceptions prevent a comparison between this fact and the existence of two pairs of testes and sperm-ducts; however, when a given species has two pairs of spermathecae and two pairs of male-ducts, and when a disappearance of one pair of the one set of organs in an allied form is accompanied by the disappearance of one pair in the other set of organs, there would seem to be some relation between the two cases; this has happened in *Acanthodrilus monocystis;* the worm is closely allied to *Acanthodrilus dissimilis* (see below), in which there is always a double set of spermathecae and male-ducts; in the former species one pair of each has vanished. Very rarely are the spermathecae median and unpaired; this state of affairs exists in the Cryptodrilids grouped together by MICHAELSEN into the genus *Fletcherodrilus*, in a few Eudrilids (e.g. *Heliodrilus*), and in the genus *Sutroa;* also apparently in the Tubificid *Vermiculus*. The fusion in the middle line of, we must suppose, originally separate and paired pouches is correlated with a similar fusion of the terminal apparatus of the male-ducts.

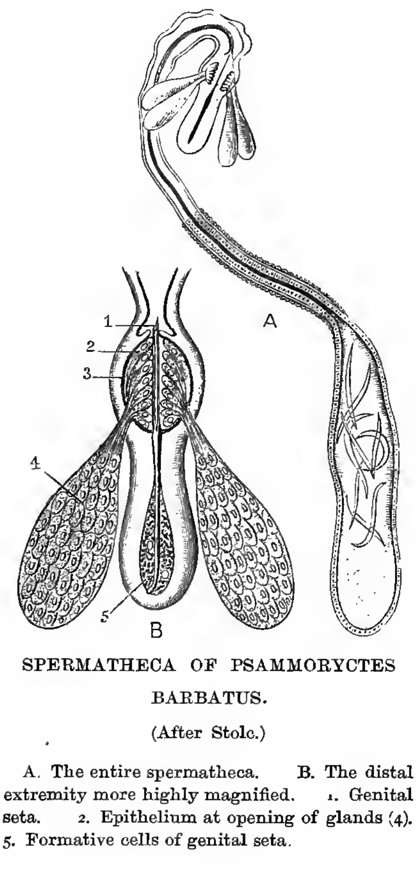
There seems to be no doubt, after the investigations of VEJDOVSKY upon *Tubifex*, and of BERGH upon *Lumbricus*, that the spermathecae arise as ingrowths of the epidermis; as to the appendices of the spermathecae, where they exist, it is not so certain; in *Perichaeta* it is common to find the appendix of large size, when the pouch itself is exceedingly small; this looks as if the appendix were phylogenetically older than the pouch, and, if so, the term appendix should be dropped or applied to the pouch itself. I failed to find in immature examples of an *Acanthodrilus* (*A. falclandicus*) any connexion between the appendix and the pouch; this almost suggests a different origin for the two.

In the neighbourhood of the spermathecae, or appended to them, there are in a few Oligochaeta, peculiarly modified setae, often accompanied by glands. They often bear the same kind of relation to the spermathecae that the spermiducal glands, with their penial setae, do to the sperm-ducts. Physiologically speaking, it is possible that the correspondence is even closer.

Among earthworms these structures have been described in the Acanthodrilids: in *Acanthodrilus ungulatus*, *A. schmardae*, and in *Benhamia beddardi* in their complete form. In the former species the ventral setae of the eighth segment are

replaced by long ornamented setae, agreeing very closely in appearance with the penial setae (on the seventeenth and nineteenth segments) of the same worm. These setae are enclosed in a thin, muscular sac, on either side of which is 'a long somewhat sausage-shaped glandular body, which communicates by a slender duct with the orifice through which the setae project on to the exterior.' The minute structure of these glands is unfortunately unknown.

Fig. 35.



SPERMATHECA OF PSAMMORYCTES BARBATUS.

(After Stolc.)

A. The entire spermatheca. B. The distal extremity more highly magnified. 1. Genital seta. 2. Epithelium at opening of glands (4). 5. Formative cells of genital seta.

Among the aquatic Oligochaeta the only species with any appendages comparable to the above is *Psammoryctes barbatus*. In this Tubificid there is a sac (see fig. 35) containing a single penial seta opening either into the spermatheca, just at its external orifice, or independently, but close to it. Two glandular sacs pour their secretion out on to the external surface by the same pore.

Of the origin of the spermathecae it is difficult to offer any hypothesis that is convincing. BERGH regards them as quite new structures developed for the purpose that they have to perform; it seems to be not proved that they have any connexion with the nephridia (see above). The occasional close relations in the way of position which the spermathecae have to some of the genital ducts, suggests a possible origin for them as diverticula of such ducts. In the genus *Phreodrilus* I have described a long coiled diverticulum of the sperm-duct, which shows, at any rate, that such diverticula can exist; I have suggested that the meaning of this diverticulum may be that it is a rudimentary second sperm-duct. In the Eudrilid *Alvania* the oviduct has a similar though smaller diverticulum; if these diverticula became separated from the ducts of which they are outgrowths, and acquired an independent opening on to the exterior, they would be of the same character as the spermathecae. Beyond these scanty facts, however, there is no evidence of such an origin of the spermathecae, probable enough though it is on *a priori* grounds. In *Eudrilus*, of course, the spermatheca is a diverticulum of the oviduct, but this instance can hardly be made use of

since the spermatheca of that worm is morphologically a different thing from the spermatheca of those types that have just been mentioned.

There are some facts which tend to prove that the spermathecae are, like the spermiducal glands (see above), derived from copulatory glands; the facts, however, are not so conclusive in this case as they are (in my opinion) in the other case. It must be noted, in the first place, that copulatory glands with modified setae occur in the neighbourhood of the spermathecae. They have just been mentioned. There are therefore no reasons against such an origin as there might perhaps be were the glands in question never present in the anterior region of the body, but always confined to the neighbourhood of the male-pores. Whether the glands in the anterior region of the body are exactly similar to those in the posterior region is not certain; some facts tend to show that they are. In *Rhynchelmis*, for example (VEJDOVSKY **5**), the albumen-gland is lined by two layers of cells, and recalls in this particular the spermiducal gland of the same species. The great similarity, too, between the setae which accompany the glands in *Acanthodrilus ungulatus* to the penial setae of the same species are facts which point in the same direction.

The spermathecae are lined with a single layer of epidermis, and appear at first to differ very greatly from the glandular bodies with which it is sought to compare them. It must be borne in mind, however, that in certain Oligochaeta—in many Enchytraeidae—a smaller or greater part of the spermatheca is covered with a glandular layer, which seems to me to be strictly comparable to the glandular investment of the spermiducal gland. Even in the higher Oligochaeta this condition is not altogether unknown. *Perichaeta houlleti* is characterized by the fact that there is appended to the spermathecae a pear-shaped body, described by PERRIER as a diverticulum, but shown by myself to be simply a mass of pear-shaped glandular cells. The relations of this to the spermatheca are very similar to those of the 'Cementdrüse' to the 'atrium' in *Tubifex*[1].

There are two other points in which the spermathecae seem to show a resemblance to the spermiducal glands, and therefore to the copulatory glands, from which it is assumed that the latter have arisen by a slight modification. In *Psammoryctes* the long spermatheca has a diverticulum which lodges a penial seta. Its relations to the spermatheca are exactly similar to those which exist between the copulatory glands and their modified setae. The other resemblance is rather with the spermiducal glands, but it obviously amounts to much the same. In *Moniligaster bahamensis* (BEDDARD **57**) and in *Moniligaster indicus* (BENHAM **16**) the spermathecae do not, as is ordinarily the case, open directly on to the exterior of the body; their

[1] Cf. also the cap of glandular cells figured by me (28) in the spermatheca of *Diachaeta littoralis*.

duct opens on to a papilla, which itself projects into the interior of a terminal sac. This is, of course, highly suggestive of the penis in the Tubificidae and in some others. I figured, but did not describe, this structure in my paper quoted above. On this hypothesis we have, of course, to account for the spermathecal diverticula, whose presence is so marked a feature of the Megascolicidae. An obvious suggestion is that they are the sacs which formerly gave rise to the copulatory setae.

2. *Spermathecae formed from mesoblastic structures.*—The Eudrilidae are characterized by the possession of spermathecae of a different kind to those that have been hitherto considered. In a few genera, as already described, there are spermathecae of the ordinary kind, only differing from those of the majority of the Oligochaeta in being situated posteriorly. In most genera, however, the place of these organs is taken by sacs which are developed from the septa, and whose cavity is therefore coelomic. I describe the variations of these more particularly under the family Eudrilidae, inasmuch as they are peculiar to that family and appear to have no relation to any other organs found among other earthworms. These sacs are generally large and generally unpaired, paired only in *Eudrilus*, *Pareudrilus*, and *Nemertodrilus;* if true spermathecae are present, these sacs involve them; if such spermathecae are not present, they open on their own account on to the exterior. Often they communicate with the sac that in the Eudrilidae generally envelops the ovaries, and they contain therefore both sperm and ova. That there should be organs performing the same function, but morphologically quite distinct, in a group which is so comparatively limited as that of the Oligochaeta, is perhaps the most remarkable fact in the economy of that group, and is not paralleled by any other structure.

I will take as an example of these structures the spermathecal sac of *Libyodrilus* (Pl. iv. fig. 1). When the worm is dissected, a large sac, extending through several segments (xiii–xviii), is seen to lie dorsally covering the gut. It is of a brownish-yellow colour, and is of an irregular elongated form, with numerous furrows on the surface which appear to indicate the possibility of distension. It has three pairs of diverticula reaching for some way down the sides of the gut. From the anterior of these arise the oviducts, one on each side. Anteriorly the sac bifurcates, embracing the oesophagus and reuniting below it. It then again divides so as to surround the nerve cord; the two branches reunite below the nerve cord before opening by the single median pore on to the exterior on segment xiii. The oviduct does not, as it appears to do, open into this spermathecal sac. A small roundish projection marks its attachment to the sac; this round body is the egg-sac, and has the structure characteristic of that organ in other Oligochaeta. Its lumen does not communicate

with the lumen of the spermathecal sac except indirectly. This communication is brought about by the oviduct, the funnel of which is drawn out into two tubes, one opening into the egg-sac, the other into the spermathecal one. In transverse sections the anterior wall of the spermathecal one is seen to be formed by the septum dividing segments xiii/xiv. The microscopic structure of the sac is as follows: it is a thickish muscular coat, the fibres of which run in various directions; imbedded in this muscular coat is a structureless sheet, which has sharp edges and is highly refractive; it is undoubtedly a membrane, and is probably elastic in nature, allowing for the distension of the sac with sperm, and its subsequent shrinkage when the sperm is evacuated. The sac is lined with cells of an irregular, somewhat elongated form, occasionally forming several pores; these cells contain numerous granules and are very similar to peritoneal cells in other parts of the body.

I have been able to trace the development of this sac through several stages. In the youngest stage I found a sac below the nerve-cord freely opening into the body-cavity; the walls of this sac were formed by the intersegmental septum xiii/xiv in front, and behind by a sheet of membrane, which traced backwards was seen to connect that septum with septum xiv/xv. The pouch was formed by the attachment of this membrane to the body-wall as well as to the septa, and was, therefore, freely open at both sides. The ovary was attached to this membrane, just where it joined septum xiii/xiv. In a later stage there was a more completely closed sac lying beneath the nerve-cord, extending for a short distance into the thickness of the body-wall; above this sac, divided to embrace the nerve-cord and dorsally to the nerve-cord, opened freely into the body-cavity; here its walls were obviously formed in front by septum xiii/xiv, and behind by the other membrane already referred to. The ovary lay between the two membranes. On the ventral surface of the body, just below the pouch, the epidermis had no gland-cells; whether it is ultimately invaginated to form the orifice of the spermathecal sac, or whether the sac bores its way to the exterior I am unable to say; but in any case the cavity of the sac evidently begins as a coelomic space.

§ 11. *Spermatophores.*

A considerable number of Oligochaeta form cases for the enclosure of packets of spermatozoa, which have been usually termed spermatophores. These were first discovered in the Lumbricidae, and from their being attached to the exterior of the body in the neighbourhood of the clitellum were regarded at one time as penes. Spermatophores, although met with in a good many Oligochaeta, are apparently by

no means universal in the group; neither do they occur in every genus belonging to those families in which they have been met with. At present they are known to exist in the following families only:—

Naidomorpha?	Geoscolicidae (*Criodrilus*).
Tubificidae.	Eudrilidae (*Polytoreutus*).
Lumbricidae.	Eclipidrilidae.

In the Naidomorpha LANKESTER (**9**) has described spermatophores in *Nais serpentina.* They are figured by him as long-coiled aggregations of spermatozoa more or less similar to the immature spermatophores of the Tubificidae, but entirely lacking the complicated structure which these bodies show when fully ripe. VEJDOVSKY (**24**, p. 153) could not, on the other hand, find any definite spermatophores in the Naidomorpha.

Among the Tubificidae the spermatophores have been known for a long time. They were figured by DUGÈS (**1**, Pl. VII, figs. 2, 4) in *Tubifex* ('*Nais filiformis*'), and termed in the description of the plate 'animalcule spermatique.' In the text it is suggested that they are too large to be probably so designated. BUDGE, though noticing the same structures, made no suggestion as to their nature.

LANKESTER has given a more detailed account of the spermatophore of *Tubifex rivulorum* in a subsequent paper (**2**), which is copiously illustrated. The spermatophore has a long, worm-like form, and generally a conical head with a collar just below; its peculiar form is due to the fact that it is moulded in the interior of the spermatheca. The spermatophore is composed of a cementing matrix in which are imbedded the spermatozoa; when fully formed it has rather a complicated structure. Centrally there is an axial band, apparently a canal, but filled with granular matter and darkly stained by carmine. External to this is a narrowish, highly-refringent band, and following this a broad band in which are imbedded the spermatozoa; these are imbedded parallel to each other and run obliquely; externally to this is another highly refringent layer, and beyond this project the ends of the spermatozoa, which are in constant vibratile motion. When the spermatophore is examined in transverse section, the spermatozoa are seen to have an imbricated arrangement which suggests that they have been fitted together by a twisting motion.

Psammoryctes has a spermatophore of a rather different form. Its most marked peculiarity is a series of recurved hooklets at one extremity; these are figured by VEJDOVSKY (**13**, Taf. viii, figs. 11, 12), but not by LANKESTER (**2**), who has also described the spermatophore of this worm. Otherwise the structure of the spermato-

phore appears to be much as in *Tubifex*. But the conical head is absent as it sometimes is in *Tubifex*.

In *Tubifex blanchardi*, lately discovered by VEJDOVSKY (**8**), the ripe spermatophores have a distinct aperture at the anterior end, which, though apparently not always (see figs. 7, 9 of VEJDOVSKY's paper), communicate with the central canal. The free ends of the imbedded spermatozoa form, as in *Limnodrilus*, a spiral upon the outer surface of the spermatophore.

A very remarkable kind of spermatophores occur in *Bothrioneuron*, where they have been described and figured by STOLC (**3**); as, however, his description is in the Bohemian language I have only been able to use the facts so far as they have been translated by VEJDOVSKY (**8**). These are invariably met with clustered round the male-pore, where they are attached to the skin.

The genus is exceptional among the Tubificidae in possessing no spermathecae; which organs in other Tubificids always contain the spermatophores. Their shape is unlike that of the spermatophores iu the other genera and is more like that of the Lumbricidae. They consist of a narrow stalk and of a more swollen distal portion which contains the spermatozoa. In the Tubificidae the spermatophores appear to be derived from two sources; the granular axis is the product of thc secretion of the 'Cement gland,' while the rest of it is produced by the epithelium of the spermathecae. This is the conclusion of LANKESTER (**2**) and VEJDOVSKY[1] (**24**); but it must be admitted that the origin is not yet definitely established. In *Bothrioneuron* there are no spermathecae, and the structure termed by VEJDOVSKY paratrium must be the place where the case is formed. The different character of the spermatophores of this Tubificid correspond to the different place of their formation.

Among the Lumbricidae spermatophores constantly occur. The most detailed account of these structures is to be found in FRAISSE's paper upon the subject. They are small chitinous sacs, of an elongated, rounded form, with a more or less distinct stalk. The dilated end is filled with sperm, and FRAISSE figures an aperture through which the sperm can escape, when the proper time arrives. There are trifling differences in form; the spermatophores vary in shape according to the species of worm. The origin — that is to say the place of formation — of these structures has been disputed; FRAISSE traces them to glands in the neighbourhood of the setae, on the first clitellar segments, which are the tubercula pubertatis. He figures, however, branching tubes in the thickness of the clitellar epithelium, composed of a single layer of columnar cells surrounding a lumen. VEJDOVSKY was

[1] The 'moulding' of the head of the spermatophore to the shape of the distal end of the spermathecae in *Tubifex rivulorum* is, of course, a strong argument.

unable to find these, and their presence, with the function attached to them by FRAISSE, seems to me to be unlikely. It is possible that the tubes in question are the nephridial ducts, which we know, from HUBRECHT'S researches (see above), often open on to the exterior at some distance from that point where they first perforate the body-wall. A main objection to the formation of the spermatophores by the tubercula pubertatis is, according to VEJDOVSKY, their frequent occurrence at points somewhat remote from these tubercula. He (VEJDOVSKY) regards the spermathecae as the site of their formation. It is not, however, necessary to go into this suggestion at length, since spermatophores exist in *Criodrilus*, where there are neither spermathecae nor tubercula pubertatis.

ROSA (**4**) has, therefore, suggested that the glandular protuberance on to which the sperm-ducts open in so many Lumbricidae is responsible for the secretion of the case of the spermatophore. This suggestion is decidedly in accord with the facts. It explains, for example, the large size of the spermatophores in *Criodrilus*, where the glands in question are largely developed, as well as the fact that they have not been discovered, in spite of diligent search, in *Allolobophora complanata*, where the swelling at the termination of the sperm-duct is wanting. The suggestion also, according to ROSA, explains the position of the spermatophores; for they are found 'always on the segments which during copulation are placed in front of the male-pores.' In *Allolobophora samarigera* the spermatophores are, most exceptionally, found dorsally on the fifteenth or sixteenth segments. The pear-shaped spermatophore thins out on all sides into a thin and leaf-like lamella, reminding one in fact of a pine seed.

Among exotic earthworms spermatophores have only been discovered (by myself **39**) in the Eudrilidae, and within that family only in the genus *Polytoreutus*. They have been found in more than one species of the genus, and are in all probability characteristic of it. The spermatophores of *Polytoreutus* are not at all like those of the Lumbricidae or of *Criodrilus*, and in fact are peculiar to the genus which they characterize, though somewhat like the immature spermatophores of *Tubifex*. They are very long, and commonly thicker at one end. They consist of a tolerably thick, transparent axis, to which the spermatozoa are attached, and within which they are but slightly imbedded.

Finally, the spermatophores of *Eclipidrilus* may be briefly described. These are stated by EISEN (**3**) to be glassy transparent bodies; they are sculptured externally with a raised spiral line; the upper extremity of the spermatophore is dilated and spherical.

§ 12. *Clitellum.*

It is almost, if not quite, certain that the clitellum exists at the period of sexual maturity in all Oligochaeta. Doubtless a good many forms exist which have not been proved to possess a clitellum, and the absence of this organ has been frequently used by some of the earlier writers as a mark of specific distinction; but many of these cases have been shown to have been inaccurately described—a clitellum being really present in the fully mature worm. The quite recent discovery of the clitellum in the families Aphaneura and Moniligastridae has eliminated any doubt as to the presence of a clitellum in the only families in which it had hitherto eluded discovery. The Moniligastridae, indeed, were placed by PERRIER in a separate group, that of the 'Aclitellians,' supposed to be distinguished by the absence of this highly characteristic organ. The failure to find it in that group was probably due to its temporary presence, or to its not by any means strongly marked appearance.

There is one genus of Oligochaeta, however, from which the clitellum may conceivably be really absent, or rather represented by a somewhat different structure. This genus is *Siphonogaster*. The male-pores of *Siphonogaster* open near to the extremity of long penial processes, which have been referred to on a previous page. The epidermis of these processes has quite the structure of the epidermis of the clitellum, and, in fully mature worms no trace of a clitellum occupying the normal position could be found. Unfortunately, as is the case with practically all the exotic earthworms, we have no such knowledge of the habits of the 'Yoruba worm' as would give a clue to the use of these long 'penial' processes. It is possible that their's may be the function of a clitellum.

With this possible exception, then, the clitellum appears to be present in all Oligochaeta—in the aquatic no less than in the terrestrial forms. Its presence indicates, with more or less accuracy, the breeding period; its function is that of producing the cocoon and when that function has ceased the clitellum disappears. The period of existence, however, seems to vary very much in different Oligochaeta. The aquatic Oligochaeta without exception, and probably the Moniligastridae also, have a fixed and definite breeding-time, during which alone the clitellum is developed. This period differs according to the species; in the case of some the autumn, in the case of others the winter, is the time of sexual activity; this restriction of the breeding period accounts for the fact that in so many of the aquatic Oligochaeta the clitellum is unknown. Other influences, too, in addition to the season of the year, are doubtless at work in retarding or accelerating sexual

maturity and, in consequence, the development of the clitellum. I kept under continual observation a quantity of *Aeolosoma tenebrarum* for more than a year without once seeing the clitellum or sexual organs.

Among the terrestrial Oligochaeta, on the other hand, particularly among the exotic species, the clitellum seems to be more or less permanent, after they have reached their full size. It is quite possible that this permanency belongs to the species rather than to the individual; but in any case it will be noted, on reference to the systematic pages of this work, how very few terrestrial Oligochaeta there are in which the clitellum is unknown. Considering that in so many cases the species are known from an examination of very few examples, collected at all times of the year, the assertion with which I have commenced this paragraph seems to be, to some extent at any rate, justified.

The clitellum is a modified tract of epidermis, whose minute structure has been already dealt with. It generally happens that the muscular layers in this region of the body have undergone some diminution in thickness, in spite of which, however, the clitellum generally stands out above the general body surface. Its colour, too, is as a rule different from the rest of the body; but not always. In the transparent aquatic Oligochaeta the clitellum, on account of its thickness, and on account of the enclosed genital products, is of an opaque white. As to minute structure the clitellum shows two principal modifications: *in the aquatic Oligochaeta*, without exception, *and in the genus Moniligaster there is only a single layer of glandular cells*, the thickness of the clitellar epidermis being thus but little in excess of that of the general body-surface. *In all other Oligochaeta*, whose minute structure has been investigated, *the clitellar epithelium is composed of several layers of cells.* This important morphological difference is not at all due to size. *Microdrilus* and *Microscolex*, besides a quantity of other terrestrial species, are no larger than *Moniligaster bahamensis*, and not so large as *Phreoryctes smithii.* The difference in the structure of the clitellum may possibly be physiological; the thinner layer of epidermis might secrete a thinner cocoon; and a cocoon deposited in water or watery mud would run less risks of having its contents dried up than one deposited near the surface of the soil. As, however, *Moniligaster* seems to be a purely terrestrial genus, this explanation cannot yet be accepted. In the meantime, therefore, I would regard the difference in the histological structure of the clitellum as a morphological difference, acquired so remotely that it cannot at present be explained by environmental or other physiological causes.

The clitellum of the Oligochaeta in naked-eye anatomical characters shows three principal variations.

(1) In most of the aquatic families, in the Perichaetidae, many Cryptodrilidae, and Acanthodrilidae, in the Eudrilidae, one or two Geoscolicidae, and in the Moniligastridae, the clitellum extends right round the body; that is to say, the peculiar modification of the epidermis is apparent throughout the entire circumference. A clitellum of this kind is sometimes spoken of as being 'complete.' ROSA has suggested that the term *cingulum* be applied to this form of clitellum, expressing its girdle-like character, and that the term *clitellum* should be restricted to the variety of the organ next to be described.

(2) In all Lumbricidae, nearly all Geoscolicidae, and in some worms belonging to the Megascolicidae, the clitellum has a saddle-shaped form; this is due to the fact that the epidermis of the ventral surface, to a variable extent (variable according to the species or genus), has not been invaded by the glandular modification of the epidermis. The clitellum has therefore a saddle-like shape[1]. ROSA attempted, at one time, to draw a hard and fast line between this kind of clitellum and the last. It is, however, not possible to draw such a line in a satisfactory way. The extremes, it is true, differ; the *clitellum* of *Lumbricus* is very different from the *cingulum* of *Perichaeta;* but there are intermediate conditions. In some worms which appear to have a completely encircling clitellum, the glandular layer is distinctly thinner on the ventral surface; in several species of *Acanthodrilus* the clitellum is complete anteriorly and incomplete posteriorly. In *Pontoscolex coretheura* the first one or two segments of the clitellum are complete; then follow a few in which the median area free from glandular modification is narrow; in the succeeding segments again this area becomes wider. The same differentiation of width in the ventral area occurs in *Rhinodrilus gulielmi.*

(3) *Aeolosoma* has a form of clitellum which is peculiar to that genus. The peculiarity consists in the fact that it is developed only on the ventral side of the body; this form of clitellum is therefore the exact converse of the saddle-shaped clitellum just described.

There is a great variation, among the Oligochaeta, in the segments which are occupied by the clitellum. This variation affects not only the number of segments included but their position; and most useful specific, generic, or even family characters are obtainable from these variations. As a general rule, there is some relation between the position of the clitellum, and that of the other organs of reproduction. Among the aquatic Oligochaeta there is a distinct relation between the position of the male-pore and that of the clitellum. In the Naidomorpha the clitellum is quite anterior in position, so too are the orifices of the sperm-ducts, which open

[1] 'Simillimam ephippio quod anteriori arcu caret' (WILLIS).

on to the clitellum. In the Tubificidae both have moved back. In the Lumbriculidae and the Enchytraeidae there is a similar relation between the male-pore and the clitellum. Among the higher Oligochaeta there is, as a rule, no such relation apparent. The position of the male-pore, though it may coincide with one of the clitellar segments, does not show any alteration in position corresponding to alterations in position of the clitellum. The male-pore, for instance, in nearly all the Megascolicidae is upon the eighteenth segment, but the clitellum is most variable in extent, though it certainly does not fluctuate much as to the segment where it commences. The Geoscolicidae show greater variation than any other family of Oligochaeta in the position of the male-pore, and yet it is impossible to trace any clear connexion between the position of the male-pore and that of the clitellum. On the other hand, the Lumbricidae show the greatest amount of variation in the position of the clitellum, combined with a nearly invariable position (on the fifteenth segment) of the openings of the sperm-ducts. As to this family, however, it must be admitted that when (*Allurus*) the male-pore is advanced a couple of segments the clitellum also commences earlier. It may be noted, also, that in the series of variations exhibited by *Perionyx excavatus* (BEDDARD **41**) an alteration in the position of the male-pore is accompanied by an alteration in the position of the clitellum.

There do not seem to be any other relations between the clitellum and any other organs in the higher Oligochaeta—excepting, perhaps, that in no case are the spermathecae situated behind the clitellum. This is, of course, connected with the function of the clitellum in forming the cocoon, which is passed over the head, receiving the contents of the spermathecae on its way.

It has been mentioned that the number of segments of which the clitellum is composed vary from species to species and from genus to genus. The smallest number of segments, viz. two, characterizes the Naidomorpha and Tubificidae, whereas we meet with the greatest number among the Geoscolicidae and Acanthodrilidae (twenty-seven in *Trigaster lankesteri*); every intermediate number is to be met with. Sometimes, as in the case of the Tubificidae, the number of segments is constant throughout the entire family; in other cases—in *Perichaeta* at any rate, the number of clitellar segments (three) distinguishes, with very few exceptions, the genus. It is difficult to detect any relation between the development of the clitellum and any structure in the worms. Why should one earthworm have a clitellum of barely three segments, and another have a clitellum of over thirty? The question is no easier to answer than that relating to the highly variable position of the organ in the genus *Allolobophora*. It is possible that there is some connexion between the extent of the clitellum and the phenomena of pairing among earthworms We know

that in *Allolobophora foetida*, though not in all species of the genus, a mucous skin is thrown off by the clitellum of the worms, which binds them together more firmly when pairing. Nothing whatever, unfortunately, is known with regard to the pairing of exotic Oligochaeta. But it is important to notice that in many of them there are various organs whose function is, possibly, that of securing a firm contact between the individuals during copulation. The papillae of *Perichaeta*, which are sometimes present, not only near to the orifices of the sperm-ducts, but also in the neighbourhood of the spermathecae, very likely perform this function; the penial setae of *Acanthodrilus*, *Megascolex*, &c., may play a similar rôle; whereas in the Geoscolicidae there is generally an absence of any structures which might be supposed to act in this way. No doubt the modified clitellar setae of these worms and of the Lumbricidae have some such function, but their effect must be feeble when compared with that of the suckers of the Perichaetidae. Now it is in precisely these forms, in which accessory copulatory structures are highly developed, that the clitellum is restricted in extent, whereas in the Geoscolicidae the clitellum is long, and accessory copulatory structures are commonly absent. It is possible, therefore, that the clitellum in these species performs a double office, i.e. (1) that of producing the cocoon, and (2) that of secreting a 'skin' to attach the two worms together during copulation. The suggestion is, however, only put forward in the most tentative fashion as it is not supported by all the facts so far as can be seen at present.

§ 13. *Genital papillae.*

There are apparently three kinds of papillae among the Oligochaeta, which have been more or less indiscriminately called 'genital papillae.'

Genital papillae occur, and have been described more particularly, in the Perichaetidae and the Lumbricidae (under the name of tubercula pubertatis); but they are also met with in other Oligochaeta; in the Acanthodrilidae there are papillae in the neighbourhood of the male-pores and elsewhere, to which Michaelsen has applied the name of 'Wollustorgane;' and organs apparently most nearly corresponding to these have been described by myself in *Pelodrilus* and in *Fridericia*.

In the Perichaetidae the papillae occur in two situations; they are found either in the neighbourhood of the male-pores or near to the spermathecal orifices, sometimes in both situations. They have proved most useful in the determination of species; the variation exhibited by them is so great that it is very often possible to define a species by their number and position. To give a few examples: in *Perichaeta forbesi* there are series of pairs of papillae upon segments xvii, xix–xxi. In

Perichaeta posthuma there are only two pairs, one on the segment in front of, and one on the segment behind, that which bears the male-pores. In *Perichaeta indica* there are no papillae near to the male-pores, but three pairs on the segments which bear the spermathecal orifices. Now in all these cases the papillae are little more than the external pores of glands, to which I have given (**78**) the name of 'capsulogenous glands;' it sometimes happens that a large number of these glands are associated together; in that case there are a group of papillae; the species *Perichaeta aspergillum* and *Perichaeta bermudensis* are partly characterized by the fact that in the neighbourhood of the male-pores, or near to these and to the spermathecal pores, are a group of orifices which belong to a mass of such glands. In *Perichaeta hilgendorfi*, BEDDARD (**30**), there is a median unpaired group of such orifices upon the eighth segment.

The glands which are associated with these papillae are solid masses of pear-shaped cells, which are no doubt of epidermic origin; they have long stalks, which penetrate the epidermis and reach the exterior; the stalks have a fibrous aspect, for they are simply the prolongations of the cells; the glands in fact, in spite of their compound appearance, are merely groups of unicellular glands; very commonly the mass of gland-cells are bound together in a common sheath; this is, for instance, the case with the species *Perichaeta hilgendorfi* just referred to; I have figured in this species a mass of these glands which are enclosed in such a sheath; it sometimes happens that these glands do not open directly on to the exterior; the two species *Perichaeta houlleti* and *P. d'udekemi* (if they be really distinct) are each provided with one or two pear-shaped glands, attached to the stalk of the spermathecae, which have been termed diverticula of the spermathecae, but which, as I showed, are merely glands of a kind perfectly similar to the 'capsulogenous glands'—different only in the fact that they do not open on to the exterior direct, but through the spermathecal duct; so that when these species are described as having no papillae, it must be remembered that they have the glands which in other forms are associated with papillae. The function of these papillae is a matter of doubt; more generally they have been held to be organs which allowed the worms to maintain a firm hold upon each other during coitus; I have suggested that their function may be that of producing albumen for filling the cocoon; and have in consequence compared them to the so-called capsulogenous glands of the Lumbricidae—glands which occur in the neighbourhood of the spermathecae, but whose structure is at present not known. No direct observations are on record which would enable this question to be decided.

Among the Lumbricidae the papillae are represented by the structures first called

by EISEN 'tubercula pubertatis.' These are swellings on some of the segments which form part of the clitellum: they appear, however, before the clitellum is developed; their structure is exactly like that of the clitellum, except that there are more unmodified hypodermic cells among them; they are rather prominent, extending beyond the general body-surface, and they afford useful specific characters by their position and number; in a few forms, for example in the genus *Allurus*, the papillae form a continuous raised band, traversing all the segments upon which it is developed without a break; it is more usual, however, for the tubercula to be paired, each pair being limited to a single segment. These organs differ morphologically from the papillae of the Perichaetidae, in that they are not associated with glands lying in the body-cavity; it is possible, however, that the difference is not one of first-rate importance; for the glands of the Perichaetidae are merely masses of glandular cells from the epidermis, which have got withdrawn into the body-cavity, but which correspond to the glandular cells which are found upon the tubercula pubertatis. I have dealt with the glands of a tubular character, which FRAISSE has described as opening on to the exterior on the tubercula, in connexion with the formation of the spermatophores.

In various Acanthodrilidae there are the papillae already spoken of as having been termed 'Wollustorgane' by MICHAELSEN; these have much the appearance of the papillae in certain Perichaetidae, but are found, on a microscopic examination, to be composed of elongated epidermic cells, and have in all probability rather a sensory than a glandular function; they are often valuable marks for the discrimination of species; I have made use of them, for example, in distinguishing the two allied species *Acanthodrilus georgianus* and *A. aquarum dulcium;* their minute structure was first made known in the former species by MICHAELSEN. These papillae are very similar to papillae which I have described in the Phreoryctid *Pelodrilus.*

§ 14. *The Cocoon.*

All Oligochaeta, without—so far as is known—an exception, form cocoons in which the ova and the sperm[1] are deposited, with or without albumen, set apart from the nourishment of the embryos. The cocoon consists of a chitinous substance, and it is formed by the activity of the clitellum; that this is the case has been proved by direct observation; thus VEJDOVSKY (9) watched the secretion of the cocoon in *Rhynchelmis* from the clitellum. As all Oligochaeta possess this organ at the time when the genital products are ripe, there is no reasonable doubt but that

[1] It does not appear certain that sperm always exists in the freshly-deposited cocoons.

all Oligochaeta produce cocoons. The number of genera and species, however, in which they are known is very limited. Among the aquatic families of this country cocoons have been generally found; the only exception up to the present is the genus *Aeolosoma*. In this genus cocoons were described by MAGGI; but more recently I adduced evidence to show that these so-called cocoons were not really organs comparable to the cocoons of other Oligochaeta, but were cysts of a temporary nature, in which the adult worm enveloped itself; my observations were confirmed by VEJDOVSKY (**2**). Among earthworms cocoons are known in but few forms. For several species of *Lumbricus*, *Allolobophora*, and *Allurus* they have been described, especially by DUGÈS and VEJDOVSKY (**9**). The cocoon of *Criodrilus* is also known. It is among the exotic genera that our information is most defective. I described some years ago the large cocoons of the huge *Megascolex coeruleus* of Ceylon; more recently FLETCHER has referred to the cocoons of a few Cryptodrilids, while SPENCER (**1**) and VEJDOVSKY (**4**) have described and figured that of *Megascolides australis*. I have dealt with the cocoons of *Octochaetus multiporus*, and have seen also the cocoons of *Acanthodrilus annectens*. BENHAM (**7**) has given an account of the cocoon of his new genus *Sparganophilus;* FLETCHER (**6**) of *Megascolex dorsalis*. This, I believe, summarizes the scope of our present knowledge.

In the Lumbricidae 'the shape of the cocoon is only characteristic for a few species,' remarks VEJDOVSKY; they are oval or barrel-shaped bodies, with a process at either end; one of the two processes is commonly thinner than the other and is sometimes frayed out into a number of threads.

In *Lumbricus rubellus* there is an obvious outer membrane, of a transparent appearance, which is prolonged beyond the end of the thinner process for a distance of 10 mm.; this membrane is soft, and minute particles of earth adhere to it; later it gets to be less soft and is, therefore, not so clear. I have found that a double membrane is also characteristic of the cocoons of *Octochaetus multiporus*. VEJDOVSKY is of opinion that this outer membrane is formed in a different situation from that where the horny inner membrane is formed: the latter is, he thinks, produced, as in the genus *Rhynchelmis*, from the epidermis of the segments which contain the gonads, the spermathecae, &c.; the soft membrane he traces to the clitellum, for the reason that worms were found with a mucous layer just thrown off from the clitellum. Direct observation, however, is wanting for the settlement of this point. There is variation in the colour of the cocoon of the Lumbricidae. In *Allurus* they are of a green colour; a yellow colour characterizes the cocoons of *Allolobophora putra*, &c.; *Allolobophora octaedra* has milk-white cocoons; in *Lumbricus rubellus* a dark brown or blackish tint is observable. The cocoon of *Megascolex coeruleus* is

of a bottle-green colour; one of the two specimens which I examined has three bands of a darker green at one end; the shape of the cocoon was much as in the Lumbricidae. In *Octochaetus multiporus* and *Acanthodrilus annectens* the cocoon has also much the same form. A considerable number of species are illustrated by VEJDOVSKY; slight variations in the form can be observed in these drawings which are more readily noticed than to be described. *Criodrilus*, on the other hand, has a cocoon of a very remarkable form. It is extremely elongated and drawn out into a fine filament at either end. HOFFMEISTER and BENHAM have figured it. In BENHAM'S genus, *Sparganophilus*, there is a somewhat elongated cocoon, but nothing like the extreme attenuation which distinguishes from that of all other Oligochaeta the cocoon of *Criodrilus*.

Among the aquatic Oligochaeta the cocoon is always of the same general form as in the higher Oligochaeta.

The actual deposition of the cocoon has been observed by VEJDOVSKY in *Rhynchelmis*. There appears to be no doubt that in this worm it is formed by the clitellum, and is a product of the hypodermal glands.

The cocoon of the Oligochaeta contains a variable amount of albuminous fluid, and more or fewer eggs, from which a greater or less number of embryos arise; the sperm, too, is voided into the cocoon so that fertilization takes place here. On the variations afforded by these characters D'UDEKEM founded (**1**) what is now, so far as concerns these facts, known to be an erroneous classification. He divided his 'Agemmes' into three families '(1) the Lombricins, (2) the Tubifex, (3) the Enchytrées.'

In the first of these the egg is minute, there are many of them imbedded in a copious albumen. In the second the egg is voluminous, there are several of them in one cocoon but no albumen. In the third there is but one egg in a cocoon and no albumen; in the last two divisions the yolk in the egg performs the function of the albumen. This classification has been since shown to be based upon inaccurate facts; VEJDOVSKY has found that in the cocoon of *Rhynchelmis*, which belongs to the second group, there is albumen, while MICHAELSEN has described more than one Enchytraeid in which the cocoon contains a considerable number of embryos.

The albumen within the cocoon is, of course, destined for the nutrition of the embryos; its characters vary; in some forms it is almost transparent and in others of a milky appearance; the latter appearance is most general among the earthworms; in *Rhynchelmis* and *Allurus* the albumen is a transparent fluid.

The number of embryos which attain to maturity within the cocoon differs in different forms; in *Lumbricus rubellus* there are one or two. In *Octochaetus*

multiporus never more than one. In *Allolobophora putra, chlorotica*, and in some others, three is the number; *Megascolex coeruleus* has two embryos—at least this was so in two cocoons of this species which I examined. In *Allolobophora foetida* there are two to six embryos. In many of these cases there are probably more ova in the cocoon than the few which give rise to worms; this is certainly the case with *Allolobophora foetida*, in which species VEJDOVSKY states that there are about twenty ova; those which do not produce mature embryos do not do so for the following reasons: either the ova are not capable of fertilization; or they are not fertilized; the egg division takes an abnormal course in an unfavourable direction; or the formation of 'twins'[1] takes place. Similar variations in the number of embryos within a single cocoon occur in the family Enchytraeidae; in some species there is but a single embryo; in others as many as sixteen.

The cocoons of the Oligochaeta are deposited in very various localities; *Rhynchelmis* attaches them to aquatic plants; those of *Ilyodrilus* are found in groups fixed to the roots of aquatic plants; many earthworms deposit theirs superficially upon the soil; others, on the contrary, lay them deep down in the ground. Those of *Megascolex coeruleus* are laid in a deep burrow; so also are those of *Allolobophora trapezoides*, according to DUGÈS (6 inches deep). *Octochaetus multiporus* selects a curious locality; the cocoons of this species, described by me some time since, were found at the edge of a swamp, which in wet seasons is covered with several feet of water.

X. GEOGRAPHICAL DISTRIBUTION[2].

In considering the distribution of the group, and in drawing conclusions therefrom, it is necessary to be very cautious in laying too much stress upon positive arguments. Negative arguments, i.e. the non-occurrence of a species in a given locality, are from some points of view more important. The reasons for this perhaps somewhat paradoxical conclusion are chiefly the accidental importation of worms from one country into another by man's agency. There is absolutely no doubt that this takes place; I have myself received earthworms from various countries accidentally included in Wardian cases: again, various species of *Perichaeta* have been met with in this country and in America in hot-houses only. On the other hand, it is perhaps rash to go to the opposite extreme, and to explain every inconvenient fact in distribution by assuming accidental importation. The facts must be treated with discretion.

[1] It is not unusual, as has been described by KLEINENBERG and VEJDOVSKY (9), for there to be double embryos, of which one only arrives at maturity.

[2] For the details of distribution see the systematic part of this volume.

The means of dispersal (other than through human agency) possessed by Oligochaeta are less than those which are possessed by many other animals. Salt water is fatal to, at any rate, many (although *Pontodrilus*, *Clitellio*, *Vermiculus*, and various Enchytraeids are, of course, exceptions); and even prolonged, though in many cases it has to be very prolonged, immersion in fresh water will drown some earthworms. Consequently, floating tree-trunks can hardly be safely made use of to explain the presence of a similar fauna on the opposite sides of a tract of sea, even if this sea were, through melting ice, comparatively fresh.

The wide distribution of many land Mollusca, which, like the Oligochaeta, are incapable of much active migration on their own account, is believed to be at least partly explicable by their transference, as adults, or as eggs in the mud which clings to the feet of birds. The cocoons of the Oligochaeta seem in many cases suitable for carriage in this fashion—more especially perhaps those of the aquatic Oligochaeta, which are not only deposited in the situations frequented by wading birds, but are small in size. With earthworms the case is rather different, for the cocoons are deposited deep in the ground. MICHAELSEN has properly drawn attention to the fact that many Enchytraeidae have cocoons from which a large number of young emerge; in such cases the transference of even a single cocoon might be sufficient to stock a new country. Among earthworms the number of embryos that reach maturity in a single cocoon is very limited.

The conditions of life of *Aeolosoma* favour its wide migration. The practice of forming cysts by the mature worm would give it a double chance (for there is presumably a cocoon formed too, though nothing is known about the matter) of being carried away accidentally.

Corresponding to the restricted capacities of earthworms for migration, we do not find, with a few exceptions to be noted immediately, that *species* are widely distributed. I may remark that I am compelled to practically leave aside the aquatic forms, owing to our comparatively small knowledge of them. The species of *Allolobophora* and *Lumbricus* form the most conspicuous exception to the above statement; but, as I point out later, there is every reason for considering their wide distribution to be due to human agency. The following species, not belonging to those families, have also a very wide range.

Eudrilus eugeniae, Africa, America, New Zealand, Ceylon, &c.

Pontoscolex corethrurus, America, Australia, India, &c., and a few *Perichaeta* (*P. affinis*, *P. indica*, and *P. houlleti*).

As to the second of these instances, it is noteworthy that the species can live on the sea-shore (as indeed its name denotes); hence there are possibly not such

difficulties in the way of its transit across the sea, as there are apparently in the case of other species If the species quoted in the above list had all been met with in temperate regions, their wide range might possibly be accounted for by human agency; and even though they are not so met with, it seems to me very possible that this is the reason for their being met with practically everywhere in the tropics. Their non-occurrence in Europe is possibly a matter of climate. It seems to me that the same arguments which I have used in order to prove that the exotic species of *Lumbricus* are introduced appears to apply in the case of these also. It is almost too remarkable in the case of *Pontoscolex*, for example, that the examples from such widely separated regions of the earth as America, India, and Australia, should belong to the same species. Now these species are always amongst the most abundant in any gathering of worms from foreign parts; this of itself shows how great would be their chance of accidental transference as compared with rarer species. But if this hypothesis be correct, how is it that other species, which are equally common in their native countries, are not also found in the same accidental way in other countries? For instance, *Stuhlmannia variabilis*, which is undoubtedly one of the species most frequently met with on the east coast of Africa. To this it is only possible to make the reply which, no doubt, largely begs the question, that some species are more fit for living under different conditions than others. It is a most remarkable fact about the Lumbricidae that they have the capacity of establishing themselves anywhere, and, moreover, of largely ousting the native inhabitants (a capacity, by-the-bye, which they share with their human fellow-creatures of their native region). In gatherings of worms from cultivated regions in New Zealand there were hardly any native species to be found; the same was the case with gatherings from the seaboard of South America. Prof. SPENCER has informed me that in Melbourne to get native species it is necessary to go well outside the town, the town gardens being filled with European species.

In the following table is indicated the range of the genera of earthworms.

1. *Neotropical region* (N).

1. Geoscolex.	8. Tykonus.	15. LUMBRICUS, N[1], P, O, E, A
2. Rhinodrilus.	9. EUDRILUS, E, O, A.	16. PONTODRILUS, P, O.
3. Anteus.	10. PERICHAETA, O, A.	17. CRYPTODRILUS, O, A.
4. PONTOSCOLEX, O, A.	11. ACANTHODRILUS, E, A.	18. OCNERODRILUS, N[1].
5. Diachaeta.	12. Trigaster.	19. GORDIODRILUS, E.
6. Onychochaeta.	13. BENHAMIA, E, O, P.	20. Trichochaeta.
7. Urobenus.	14. Kerria.	21. MICROSCOLEX, P, A.

22. MONILIGASTER, O.

2. *Nearctic* (N^1).

1. LUMBRICUS, N, P, O, E, A.
2. Diplocardia.
3. Plutellus.
4. OCNERODRILUS, N.

3. *Ethiopian* (E).

1. ACANTHODRILUS, N, A.
2. BENHAMIA, N, O, P.
3. PERICHAETA, N, P, O, A.
4. MEGASCOLEX, O, A.
5. PERIONYX, O.
6. Pymaeodrilus.
7. GORDIODRILUS, N.
8. Microchaeta.
9. Kynotus.
10. Siphonogaster.
11. Ilyogenia.
12. Callidrilus.
13. EUDRILUS, N, O, A.
14. Eudriloides.
15. Nemertodrilus.
16. Polytoreutus.
17. Stuhlmannia.
18. Pareudrilus.
19. Notykus.
20. Metadrilus.
21. Megachaeta.
22. Heliodrilus.
23. Libyodrilus.
24. Hyperiodrilus.
25. Alvania.
26. LUMBRICUS, N, N^1, P, O, A.
27. DICHOGASTER, A.

4. *Palaearctic* (P).

1. LUMBRICUS, N, N^1, E, O, A.
2. MICROSCOLEX, N, A.
3. PERICHAETA (?), N, E, O, A.
4. Sparganophilus.
5. Hormogaster.
6. PONTODRILUS, N, O.
7. Criodrilus.
8. BENHAMIA, N, E, O.

5. *Oriental* (O),

1. MONILIGASTER, N.
2. PONTOSCOLEX, N, A.
3. Glyphidrilus.
4. Annadrilus.
5. EUDRILUS, N, E, A.
6. Typhoeus.
7. Deodrilus.
8. CRYPTODRILUS (?), A, N.
9. PERICHAETA, N, E, P, A.
10. MEGASCOLEX, E, A.
11. PERIONYX, E.
12. Pleionogaster.
13. BENHAMIA, N, E.
14. Bilimba.
15. Microdrilus.
16. Desmogaster.
17. PONTODRILUS, N, P.

6. *Australian* (A).

1. MEGASCOLEX, O, E.
2. PERICHAETA, O, N, P, E.
3. CRYPTODRILUS, N, O.
4. Megascolides.
5. ACANTHODRILUS, N, E.
6. MICROSCOLEX, N, P.
7. Plagiochaeta.
8. Octochaetus.
9. Deinodrilus.
10. Diporochaeta.
11. Digaster.
12. Perissogaster.
13. EUDRILUS, N, E, O.
14. PONTOSCOLEX, N, O.
15. LUMBRICUS, N, N^1, P, O, E.
16. DICHOGASTER, E.

It will be seen from the tables that the Neotropical and Ethiopian regions are richest in genera, and that they are at the same time richest in genera peculiar to each of them, and found nowhere else. The Ethiopian region is the richest in both; and this fact gets additional weight from the consideration that Africa has been, perhaps, less explored than America and the West Indies from the present point of view.

The Oriental and Australian regions are nearly equal to each other, both in the number of genera and in the number of peculiar genera, and both of them are some way behind the Neotropical region in both respects.

Then comes the Palaearctic region and finally the Nearctic.

The above tables are too accurate in one respect to bring out the essential characters of the earthworm fauna of the different regions. In the Oriental region, for instance, *Moniligaster* and *Perionyx* are very characteristic forms, and are both represented by a number of species. If it were not for a single *Moniligaster* (*M. bahamensis*) in the Bahamas, and a single *Perionyx* (*P. sansibaricus*) in the Ethiopian region, these two genera would be absolutely limited to the Oriental region. In the same way *Cryptodrilus* is confined to Australia, excepting for two doubtful instances. One of these is *Cryptodrilus spatulifer*, which, as I point out (below), is really perhaps in strictness not referable to that genus. The other exception is a Cryptodrilid, which I received myself some years ago from India, but whose identity with *Cryptodrilus* I should not like to positively assert.

Megascolex ought really to be struck out of the list of Ethiopian earthworms, as it only just gets into that region with one species (*Perichaeta madagascariensis* = *Megascolex armatus*) in Madagascar. So, too, as already remarked, *Perionyx*.

The following list indicates the characteristic genera of the several regions; those which are abundant in individuals or species, or both, or are absolutely confined to the region in question, though not abundant.

Neotropical.

1. Geoscolex.	6. Urobenus.	11. Trigaster.
2. Rhinodrilus.	7. Tykonus.	12. Benhamia.
3. Anteus.	8. Trichochaeta.	13. Kerria.
4. Diachaeta.	9. Perichaeta.	14. Gordiodrilus.
5. Onychochaeta.	10. Acanthodrilus.	15. Microscolex.

Oriental.

1. Moniligaster.	3. Annadrilus.	5. Deodrilus.
2. Glyphidrilus.	4. Typhoeus.	6. Microdrilus.

7. Desmogaster.
8. Bilimba.
9. Perichaeta.
10. Megascolex.
11. Perionyx.
12. Pleionogaster.
13. Benhamia.

Australian.

1. Megascolex.
2. Perichaeta.
3. Cryptodrilus.
4. Megascolides.
5. Acanthodrilus.
6. Octochaetus.
7. Deinodrilus.
8. Plagiochaeta.
9. Diporochaeta.
10. Digaster.

Ethiopian.

1. All Eudrilidae.
2. Benhamia.
3. Pygmaeodrilus.
4. Gordiodrilus.
5. Microchaeta.
6. Kynotus.
7. Ilyogenia.
8. Callidrilus.
9. Millsonia.
10. Nannodrilus.
11. Siphonogaster.

Nearctic.

1. Plutellus.
2. Lumbricus.
3. Diplocardia.

Palaearctic.

1. Lumbricus.
2. Hormogaster.
3. Sparganophilus.
4. Criodrilus.

The genera can in reality (in my opinion) be sorted in a better way. It is not obvious from the above lists that there is a close resemblance between the Nearctic and Palaearctic regions; and yet there is, owing to the fact that *Lumbricus* (*s. l.*) is the dominant genus in both. But it is a question how far this fact ought to lead one. I have pointed out (p. 150) that although *Lumbricus* is a genus of world-wide distribution, the exotic species are invariably identical with European forms; were the former indigenous to those countries instead of being, as is probable, introduced by man's agency, they might be fairly expected to be not identical with European forms. To the case of N. America this argument cannot perhaps be so readily applied, on the grounds of its recent continuity with Asia. It must be borne in mind, however, that there are but few American species which are not also met with in Europe.

I leave this question, however, undecided. It does, however, appear to be clear that the Australian region can have, as regards earthworms, no existence. To begin with, New Zealand is essentially different from Australia. The prevalent forms in Australia are Perichaetidae and Cryptodrilidae; the most abundant worms of New Zealand are Acanthodrilidae. There are a few species of the two former families in New Zealand and three species of *Acanthodrilus* in Australia. The Australian continent shows, in fact, far closer resemblances to the Oriental region. In both the Cryptodrilidae and Perichaetidae are the prevailing forms. But the *genera* of the Oriental region are for the most part different, or, if identical, are more or less abundant than in Australia. Thus *Perichaeta* is the dominant Perichaetid in India and Malaya, and *Megascolex* in Australia, though both genera occur in both regions. As regards the Cryptodrilidae there are (with the doubtful exception of *Cryptodrilus*) no genera in common. I do not in fact propose to merge the Australian and Oriental regions; but rather to dwell upon the resemblances in order to accentuate the differences between Australia and New Zealand. The latter islands do not, however, stand sufficiently alone to warrant the introduction of a special region (as was proposed by Mr. Huxley for other reasons). The characteristic earthworms of New Zealand are Acanthodrilidae—four genera, of which three are peculiar, and two of which (*Deinodrilus* and *Plagiochaeta*) are very well marked; but the same family (the genus *Acanthodrilus* only) is equally characteristic of Patagonia and the adjacent islands. The only earthworms known from Marion and Kerguelen islands are also *Acanthodrilus.* These facts seem to me to be sufficiently important to require the formation of an Antarctic region, circumpolar in extent. I am not inclined to put the Cape part of Africa in this region. Though Acanthodrilids occur there these are also abundant throughout tropical Africa. It seems very possible that a former greater extension northwards of the Antarctic continent may account for those Acanthodrilids; but the equally great or greater prevalence of Geoscolicids, and especially of Eudrilids, distinguish undoubtedly the Ethiopian region.

The facts at present known about the distribution of earthworms lead me to divide the world into the following regions:—

(1) Palaearctic (excluding Japan, but including Africa N. of Sahara);
(2) Nearctic;
(3) Oriental;
(4) Australian (the continent of Australia only?);
(5) Antarctic (New Zealand, islands of Antarctic ocean, Patagonia);
(6) Ethiopian;
(7) Neotropical (including Central America and West Indies).

I do not attempt the islands of the Pacific, concerning which there is not enough information.

I have already referred to the resemblances between the Oriental and Australian regions. The latter is, as has been said, sharply marked off from the Antarctic; nor is there a close resemblance between the Oriental and Ethiopian. The latter is, of course, especially characterized by the Eudrilidae, which, with the exception of the cosmopolitan *Eudrilus*, are restricted to that region. Some naturalists see a close affinity between the Neotropical and Ethiopian regions.

The distribution of earthworms offers a certain amount of support to this contention. It will be observed that in both continents the family Geoscolicidae enters largely into the composition of the fauna, more, though, it is true, in the case of America than of Africa. It is also, as I point out later, possible to differentiate the old world from the new world Geoscolicids. It seems possible that these resemblances, as also the prevalence of Acanthodrilids in both continents, is due to the former extension northwards of the Antarctic continent.

PART II. SYSTEMATIC.

THE CLASSIFICATION OF THE OLIGOCHAETA.

Before advancing the scheme of classification of the group which will be adopted in the present work, it is necessary to give a slight sketch of the principal previous systems.

Historical Survey. LINNAEUS referred such members of the modern order Oligochaeta as he was acquainted with to two different orders of his class Vermes. *Nereis lacustris* (=*Stylaria lacustris*) was placed among 'Vermes Mollusca,' *Lumbricus* among 'Vermes intestina.'

In the thirteenth edition of the 'Systema Naturae,' GMELIN retained this classification and added to 'Vermes Mollusca' the different species of *Nais* (described by O. F. MÜLLER); to 'Vermes intestina' were assigned species of the modern genera *Tubifex, Lumbriculus,* and *Enchytraeus.*

CUVIER included all the Oligochaeta, together with the Leeches, in one order, *Abranchia,* of the *Annulata*; a subdivision of the *Abranchia,* 'Abranches sétigères apodes' included the two families Lumbricina and Naides.

The first classification of the Oligochaeta which is of real value, being based upon an anatomical investigation, is that of Jules D'UDEKEM; this classification he adhered to throughout. At first Milne EDWARDS'S name for the group 'Annélides sétigères abranches' was retained; later SAVIGNY'S term 'Lumbricina' was made use of. The group is divided into two, Monoica and Dioica. The Dioica include the Capitellidae; the Monoica correspond to the Oligochaeta as now understood (i.e. with the exclusion of the Capitellidae) and are divided into 'Agemmes' and 'Gemmipares.' The 'Agemmes' contain three families (1) Lumbricidae, (2) Tubificidae, (3) Enchytraeidae; the 'Gemmipares' only one family Naideae. The distribution of genera in these families

is as follows—(1) Lumbricinae (*Lumbricus*); (2) Tubificidae (*Tubifex, Lumbriculus, Rhynchelmis*); (3) Enchytraeidae (*Enchytraeus*); (4) Naideae (*Dero, Nais, Aeolosoma, Chaetogaster*).

The 'Gemmipares' are distinguished from the 'Agemmes' by the fact that the sexual organs are always present, while in the 'Agemmes' the sexual organs only make their appearance at certain times.

The Lumbricidae, Tubificidae and Enchytraeidae are separated by the following characters.

CLAPARÈDE distinguished the Oligochaeta from other Annelids and divided them into two groups.

(1) *Terricolae.* With two ventral blood-vessels (one above, one below the nerve-cord) with 'segmental organs' in the segments which contain the spermathecae and reproductive ducts; the clitellum developed behind the male sexual pores; a vascular network on the segmental organs. Genera *Lumbricus* and probably *Hypogaeon*, and *Criodrilus.*

(2) *Limicolae.* With one ventral blood-vessel (above the nerve-cord) without segmental organs in the genital segments; the male-pores opening on to the clitellar segment. No vascular network on the segmental organs.

Genera *Tubifex, Limnodrilus, Clitellio, Lumbriculus, Nemodrilus, Enchytraeus, Pachydrilus, Nais, Stylaria, Chaetogaster, Euaxes* (=*Rhynchelmis*), *Serpentina, Aeolosoma.*

The next classification of the group is that of G. JOHNSTON. The division of Oligochaeta (termed by him Scoloces) included also the Capitellidae; it was divided into two tribes:—

I. Lumbricina. II. Naidina.

The Lumbricina were again divided into two families:—

(1) Lumbricidae, genera *Lumbricus, Saenuris, Enchytraeus*;

(2) Littorales, *Clitellio, Valla* (=*Capitella*).

The Naidina has only one family Naidea with genera *Proto, Stylaria, Serpentina, Nais, Chaetogaster.*

The classification of Léon VAILLANT is as follows:—

Order ANNÉLIDES LOMBRICINES.

I. Lumbricina. Setae simple.

(1) Lumbricina propria. Setae isolated or grouped in pairs. *Perichaeta, Megascolex, Pontoscolex, Hypogaeon, Echinodrilus, Lumbricus, Helodrilus, Criodrilus, Euaxes, Trichodrilus, Phreoryctes.*

(2) Enchytraeina. Setae three or four in number in each bundle. *Enchytraeus, Pachydrilus.*

II. Naidea. Setae bifid or hair-like, at least partly, rarely pectinated.

(1) Naidea propria. Setae in four rows, exceptionally biserial, and then all hair-like. *Heterochaeta, Stylodrilus, Lumbriculus, Clitellio, Tubifex, Nais, Aulophorus, Mesopachys, Aeolosoma.*

(2) Chaetogastrina. Setae biserial, never hair-like. *Chaetogaster, Ctenodrilus.*

BENHAM (1) has proposed a classification which is really not different from that of D'UDEKEM. He divides the class into two sub-classes:—

I. Naidomorpha. II. Lumbricomorpha.

In the first sub-class are the families Aphaneura, Naididae, Chaetogastridae (and the genus *Ctenodrilus*).

It is defined thus:—'Small worms of relatively few somites; blood uncoloured; male genital pores in front of the seventh somite, or in this somite. Asexual as well as sexual reproduction occurs.'

The Lumbricomorpha are thus defined:—'Reproduction only by sexual process; no cephalization; somites behind the peristomium all similar; and setae are similar throughout the body, except in special regions, e.g. on clitellum. Male genital pores behind the seventh somite. No eye spots (? *Helodrilus*, HOFFMEISTER).

This sub-class is divided into Order I—Microdrili (*Lumbricomorpha minora*); Order II—Megadrili (*L. majora*).

To these the terms 'waterworms' and 'earthworms' may be applied. The only constant difference between the two orders is the absence (Microdrili), or presence (Megadrili) of a capillary network of blood-vessels on the nephridium. A number of characters *usual* to the two groups then follows.

How far can the separation of the aquatic Oligochaeta, advocated by Claparède and others, be held now in the light of greater knowledge of the organization of the group?

There are, undoubtedly, a certain number of points in which all these forms agree to differ from the terrestrial Oligochaeta; that is, when the structural features to be referred to are considered collectively. And there are furthermore a few points which at present are peculiar to the aquatic Oligochaeta. We will commence with the latter; among all the Oligochaeta which belong to Claparède's 'Limicolae,' the ova are of large size and full of yolk; this holds good, without a single exception, from the smallest Enchytraeid up to so large a form as *Phreoryctes.* Corresponding, no doubt, to this, the egg-sacs are of large size and extend through several segments; both they and the sperm-sacs are very thin-walled, and their interior is entirely undivided by trabeculae; in all, or at least very nearly all, of the aquatic Oligochaeta there is a head-pore, a structure which is, so far as our knowledge at present goes, quite unrepresented in the terrestrial Oligochaeta. The remaining point of difference concerns the structure of the body-wall; the longitudinal fibres consist of a single row of deep fibres only; this, however, does not characterize *Phreoryctes*, a genus which in other characters occupies an intermediate position.

Besides these resemblances, all the aquatic Oligochaeta agree in a number of structural features which would, if it were not for the family Moniligastridae, distinguish them from all the terrestrial Oligochaeta; these are:—

(1) The clitellum is only a single layer of cells thick.

(2) It has a very anterior position, more so than in any terrestrial form.

(3) The male-pores are also far forward.

(4) The sperm-duct traverses only two segments.

If we add the family Moniligastridae, it seems to me that a perfectly natural group of Oligochaeta will be the result; this group will be capable of the following definition.

Oligochaeta with a clitellum commencing not later than the tenth or eleventh segment, and consisting of only a single layer of cells; sperm-ducts only occupy two segments, the external pore being on the segment following that into which the funnel opens; male-pore situated in front of the female-pore; eggs generally large, always provided with abundant yolk; egg-sacs large; spermiducal glands, when

present, possess a muscular layer interposed between the inner epithelium and the glandular layer; sexual maturity at a fixed period.

In the above definition a number of characters are left out which do occur in all of the families which are contained in this group, but which also occur in the higher Oligochaeta; such are, for example, the invariably paired nephridia and the absence of a sub-nervian blood-vessel. The only genus among those not included in this group which presents any resemblance to it in any one of the points mentioned is *Tetragonurus*, in which the male-pores (presumably: its anatomy is not known) are only a segment behind that which contains the funnel. It appears to me, therefore, that the above definition is really sufficient to separate off a group of natural distinctness. And I propose to retain BENHAM'S name of 'Microdrili' for this group.

The differences which *Moniligaster* shows from the other members of the group are not in my mind so great as the differences which it shows from other earthworms; it agrees with earthworms in having gizzards, in the thickness of the body-wall, and in the presence of specially thickened septa. But a little consideration will show that these characters are not by any means distinctive of earthworms; the genus *Pelodrilus* is surely more akin to *Phreoryctes* than to any other family; and it has thick body-walls and thickened septa. The presence of gizzards is really the only point in which *Moniligaster* is more like earthworms than any aquatic form; but are we to decide a question of affinity on so variable a structure as the gizzard, absent in so many earthworms, and possibly connected to some extent with the habitat of the creature? In considering this proposed grouping, too, a number of other structural features must be taken into consideration, which are important, though not distinctive of the group. I have described, and so has BENHAM (**16**) in a different species, a protrusible penis in *Moniligaster*, which is exactly like that of the Tubificidae, and has not its exact counterpart in any genus of worms which do not belong to the Microdrili, as I here define them. All the Microdrili, with the exception of the Moniligastridae, have no nephridia in the anterior segments of the body; but this fact cannot form the basis of a first grouping, since there are some undoubted members of the Oligochaeta which could not be placed in the Microdrili, though they show the same structural character: the genus *Pontodrilus* is a case in point. Nor can any stress be laid upon the fact that the nephridia of *Moniligaster* have a vascular network; this is, it is true, absent in the aquatic worms, but it is also absent in *Gordiodrilus* and some of its allies, which are not in other respects close to the aquatic families. In fact, there seems no way out of associating together closely the Moniligastridae and the Limicolae of CLAPARÈDE, and making one family of them. Is it possible to pursue this arrange-

ment further, and to make one group of the remaining Oligochaeta? ROSA has associated all the terrestrial genera (including *Moniligaster*) into a group 'Terricolae.' It is difficult, however, to get together a number of characters of first-rate importance, in which they agree to differ from the Microdrili. The following list appears to me to embody all the characters which the different families of earthworms have in common:—

(1) The clitellum never commences before the twelfth segment.

(2) Its minute structure differs from that of the Microdrili, consisting always of two layers of cells.

(3) The ova are invariably small, and with little yolk.

(4) The sperm-ducts traverse two or more segments on their way to the exterior.

(5) The egg-sacs are small.

(6) The spermiducal glands, when present, have not a muscular layer interposed between the two layers of the lining epithelium.

(7) Sexual maturity seems to be more or less continuous.

(8) Oviducal pores invariably upon segment xiv, while ovaries are in segment xiii[1].

We might perhaps add the invariable three pairs of nerves given off in every segment from the nerve-cord. The number varies in the Microdrili.

These characters are simply the reverse of those which I have used to define the Microdrili; and they are, therefore, naturally in some cases negative characters, which are not always of such value as positive characters. For example, the fact that the sperm-ducts traverse more than one segment on their way to the exterior is a vague character, because the number of segments traversed is a variable one; in some earthworms fewer, in others more, segments lie between the external and internal orifices of the ducts. The clitellum, again, is exceedingly variable in position, much more so than it is in the Microdrili. In spite of this, I consider that the characters which remain are enough to indicate a community of descent of all the different families which are included by ROSA in his group Terricolae.

The next question to be examined is the relation between these two groups. Can one, for example, be derived from the other, or are they both traceable only to a common stock? The facts, as to the influence of an aquatic life upon normally terrestrial forms, seem to tend to the conclusion that there is hardly any evidence of the characteristics of the Microdrili having been caused (except perhaps by a very prolonged exposure to those influences) by their aquatic life; and, besides, those very characters are found in the terrestrial *Moniligasters*, which at least indicates that, if they are due to environment, it is a long time in acting, since *Moniligaster* is distinctly

[1] Exceptions to this general statement which have been recorded (cf. *Rhinodrilus proboscideus*) require confirmation.

a terrestrial form in habit, and bears no *superficial* resemblances to the aquatic Oligochaeta. All these facts seem to indicate a gulf between the Microdrili and the Megadrili (as I would call the *earthworms*, following BENHAM'S nomenclature).

Aeolosoma, as it appears to me, must undoubtedly form a group by itself. In many respects it is barely an Oligochaet. I refer particularly to the absence of specialized sperm-ducts, whose proper function is taken by at most slightly-modified nephridia; this state of affairs recalls the Capitellidae and the Saccocirridae, in both of which families the generative ducts are apparently slightly-modified nephridia. The clitellum is so far unlike that organ in other Oligochaeta (except certain Enchytraeidae) that it is only developed on the ventral surface of the body; where the clitellum is deficient in other Oligochaeta, it is precisely here (on the ventral surface) that the deficiency occurs. The only characteristically Oligochaetous feature in the generative system seems to be the spermathecae. It is also the only Oligochaet in which there are a pair of ciliated pits at the sides of the head. These occur, as is well known, in some of the 'Flatworms' and Nemertines; they are also found in a few Polychaeta, for instance in *Saccocirrus*. It may be that a ciliated organ which I discovered (**51**) in the embryo of *Octochaetus multiporus* is referable to the same category; this organ, however, was a prominence, not a depression, of the integument; it had a bunch of particularly long cilia upon it.

The ciliation of the prostomium is another absolutely distinctive character of *Aeolosoma;* this, again, while not occurring in any Oligochaet, is met with in *Saccocirrus* and *Ctenodrilus*, two genera of perhaps doubtful position, but more nearly related to the Polychaeta than to the Oligochaeta.

As to the absence of the ventral nerve-cord, this may not be really so entirely absent as would appear from most of the published descriptions of the anatomy of the genus. To begin with, VEJDOVSKY found the rudiments of a cord in the shape of more or less scattered cells; it is also possible that the ventral nerve-cord may be in connexion with the epidermis, as the cerebral ganglia certainly are. If the ventral nerve-chain be really absent, it might be put down to degeneration; I should certainly be disposed to credit a process of degeneration with the almost complete absence of internal segmentation. A final peculiarity, very distinctive of the genus, is its habit of temporarily encysting itself in a chitinous cyst.

These characters, taken together, seem to me to necessitate the placing of *Aeolosoma* in a group by itself, a group equivalent to either of the Microdrili and Megadrili; it may even be that this separation is not wide enough; there would be no great violence done to the systematic position of the genus if the group to which I refer it were regarded as the equivalent of both the Microdrili and the Megadrili.

The group Aphaneura may be thus defined:

Oligochaeta with a clitellum confined to the ventral surface, with no male-ducts, the female-ducts being replaced by a median pore, prostomium ciliated on the under surface, ciliated pits on the head, reproduction by budding as well as by the sexual process.

As to the further division of the Microdrili, no one will dispute the justice of placing in separate families (1) the Enchytraeidae, (2) the Moniligastridae, (3) the Phreoryctidae. The remaining families of Naidomorpha, Tubificidae, and Lumbriculidae, I associate into one superfamily, giving my reasons for doing so on a subsequent page; this will form a fourth group, the Lumbriculides.

The wide range of variation in structure exhibited by earthworms permits the group to be broken up into families.

This has been done by PERRIER (3), VEJDOVSKY (24), BENHAM (1), and ROSA (20), but there is some difference in the classificatory systems of these authors.

PERRIER'S classification[1] depends primarily upon the relation of the male generative orifices to the clitellum; according to the position of the male generative orifices, earthworms are divided into the following four groups:—

(1) *Anteclitellians:* in which the male generative pores are *in front of* the clitellum;

(2) *Intraclitellians:* in which the male generative pores are *within* the clitellum;

(3) *Postclitellians:* in which the male generative pores are *behind* the clitellum;

(4) *Aclitellians:* in which there is no clitellum.

The last division—that of the *Aclitellians*—cannot be defined as PERRIER defined it, inasmuch as BOURNE (2) has discovered a clitellum in several Indian species of the genus *Moniligaster*, of which genus alone the group consists. But the systematic position of *Moniligaster* has been already discussed.

As ROSA (20) has pointed out, the classification of PERRIER is artificial and must be abandoned for three reasons:

(1) It places in different groups genera which have close affinities in other respects. An instance of this is *Megascolex* and *Perichaeta*; the former genus is 'Intraclitellian' the latter 'Postclitellian'; and yet *Megascolex* agrees with *Perichaeta* in such an important point as the possession of numerous setae arranged in a ring round the middle of each segment.

(2) It separates species of the same genus.

In the genus *Acanthodrilus* the following species are 'Postclitellian': *A. obtusus, A. ungulatus*; the following are 'Intraclitellian': *A. schlegelii, A. novae-zelandiae, A. dissimilis.*

(3) It separates even individuals of the same species.

In some examples of *Microscolex modestus,* ROSA found the generative pores behind the clitellum, in others within.

PERRIER himself remarked that *Eudrilus* seemed to be a transitional form between the Intra- and Postclitellian; the male sexual pores are within the clitellum, but the general organization of the worm was rather that of the Postclitellian; and this principally for the reason that the male reproductive ducts were furnished with prostate glands. In the present state of our knowledge,

[1] This classification assumes that earthworms form a group 'Terricolae' equivalent to the 'Limicolae.'

however, it is not possible to base any such wide distinctions on the presence or absence of 'prostate' glands; since there are plenty of instances in which Intraclitellian male generative pores are associated with the presence of prostate glands.

The classificatory scheme of VEJDOVSKY (24) is in some respects an improvement of that of PERRIER. BENHAM carries in my opinion to too extreme a point the classification according to the excretory system originally proposed by myself.

It does not appear to me that any of the schemes advanced express the total facts now known about the structure of the Oligochaeta.

In the course of the following pages I have dealt with the mutual affinities of the different families to one another; and for all details the reader is referred to these places. Summing up briefly the results put forward in detail, I may point out that the Acanthodrilidae, Perichaetidae, and Cryptodrilidae, form a natural assemblage which I make into a superfamily, Megascolides. In all the members of this group (with very few exceptions) there are spermiducal glands which are unconnected with the sperm-ducts, or into which the sperm-ducts only open near to their external orifice; these glands, too, are entirely without an external muscular sheath. Sharply marked off by this character, the Megascolides are also the only Terricolae in which there is a 'plectonephric' excretory system, and they are the only group in which the setae are often more than the 'typical' eight.

A group of equal importance is that of the Eudrilidae. In this group the sperm-ducts open into the spermiducal gland always, and far up it in the glandular part of the organ. This character does not, it is true, absolutely distinguish them from the next family, that of the Geoscolicidae; but in the Eudrilidae there are so many structures which are, without being universal, so widely spread and so peculiar that it is, I think, necessary to regard the family as a distinct one. Such characters are the presence of a system of coelomic sacs, involving the female organs of generation and forming a spermathecal sac, the existence in the integument of organs probably of a sensory function and of peculiar form; the frequent network formed out of the nephridial ducts and lying in the skin.

The Geoscolicidae and the Lumbricidae are the only remaining families of the Megadrili.

PHYLOGENETIC ARRANGEMENT OF THE OLIGOCHAETA.

The difficulty (greater in some cases than in others) of defining the various families of the Oligochaeta seems to show that there can be no question here of deriving the group from two or more stocks; if we were limited to the types at the extreme outskirts of the group such as *Aeolosoma* and *Eudrilus*, this view might

be tenable; but these, and other equally or nearly equally different types, are connected by so many intermediate forms, that the difficulty is not in uniting them into the same large group, but in finding adequate characters by which most of the families and genera can be differentiated. There is in fact no doubt, in my opinion, that the group Oligochaeta is a perfectly natural one. This being the case it is desirable to attempt a general sketch of the interrelationships of the several families, which shall indicate the most probable evolution of the class. In attempting a solution of this problem, no help is to be obtained from Palaeontology, and very little from Ontogeny; the development of only four types is known, viz. *Lumbricus* (various species), *Acanthodrilus*, *Rhynchelmis*, and *Enchytraeus* (*s. l.*). Many different opinions have been held as to the relative positions of the different families; ROSA has argued in favour of the archaic position of the Acanthodrilidae; I have urged the claims of the Perichaetidae to occupy the lowest place in the series; BENHAM has recently put forward the view that the terrestrial Oligochaeta are the most modern group, and that some family (not particularized) of the 'Lumbricomorpha minora' are to be looked upon as their ancestors.

ROSA'S opinion was mainly based upon the occasional doubling of the dorsal vessel in the Acanthodrilidae, which is known to be an embryonic trait, and upon the presence of eight nephridia per segment in *Octochaetus multiporus*. Since then so many worms have been found to possess a 'plectonephric' condition, and the double dorsal vessel has been met with so frequently, that more is wanted before the Acanthodrilidae can be accepted as the primitive family. My own arguments chiefly rested upon the structure of the nephridia in *Perichaeta*; embryology has apparently shown that the plectonephric condition was preceded by paired tubes, though it is still not proved that the paired nephridia of existing genera are the precise equivalents of the embryonic nephridia of *Octochaetus* and *Megascolex*.

As regards the earthworms, at any rate, it seems to me to be not so difficult a task to arrange them, if only the starting point could be agreed on; the aquatic families, on the other hand, are more puzzling; this is a good deal due, I should imagine, to the fact that our knowledge of them has by no means kept pace with our knowledge of the terrestrial forms; this is particularly to be regretted, in view of the fact, that all probability points to the origin of the terrestrial forms from aquatic and not *vice versa*; this cannot, I think, necessarily mean that we must look for the oldest type of Oligochaeta among the existing aquatic genera already known. Continuing our general *résumé* of the conditions which would on *a priori* grounds suggest an archaic position, we may refer to wide and discontinuous distribution; many undoubtedly ancient forms show this; a familiar example is

Peripatus; so, too, are the Struthious birds, the marsupials, &c. There are but few Oligochaeta which fulfil this condition, and arguments based upon it would be unsafe; still it may be worth while to point out, without laying too much stress upon the facts, that *Moniligaster* found in India and the Bahamas is an example; perhaps, too, *Ocnerodrilus* is one; the genus occurs in the West Indies, South and Central America on the one hand, and in tropical Africa on the other. *Perichaeta* is perhaps a better example still; the impression gained from the details as to the distribution of this genus given in the present work may not appear at first sight to favour this statement; the genus is, it is true, found in most parts of the world; but it has, nevertheless, a somewhat discontinuous distribution; it is excessively abundant in India and the neighbouring parts of Asia; this is, indeed, the head quarters; it is rare at the very most in tropical Africa, and reappears, though it is not common, at the Cape. Three species of *Perichaeta* (*s. s.*) live in Australia, together with a number of *Megascolex*; it is very common in several islands of the West Indian group, rarer in South America. The distribution of the family does not suggest a migration from the head quarters, except in the case of the genus *Megascolex*; it is rather suggestive of a former universal range which has become here and there limited, and here and there perhaps increased in numbers where there has been but little competition. The distribution of worms in Australia offers particularly useful data; if the general theory to account for the almost entire absence of placental mammals from this region of the globe be accepted, we should argue that the Geoscolicidae, which are totally absent from Australia[1], are a comparatively modern type, while the Perichaetidae and the Cryptodrilidae, which are so abundant there, are more ancient; this is quite in agreement with the other facts; for there can be no doubt that the Cryptodrilidae are very nearly akin to the Perichaetidae.

In considering the distribution of earthworms we are always fairly sure of our deductions, if we can only eliminate the interference of man; the Perichaetidae and Cryptodrilidae are too abundant in Australia to allow of our explaining their presence by artificial introduction; they must obviously be indigenous to that country; the occasional occurrence of a species in a country far from its usual habitat, may, of course, be a fact of importance; but, considering the possibility of accidental transport, it is not as a rule striking. I should be inclined, therefore, to lay some stress upon the probability of the archaic nature of the characteristic earthworms of Australia.

Apart from geographical distribution there appear to me to be other characters which tend to argue for the primitive position of the Perichaetidae among earthworms.

[1] *Pontoscolex corethrurus* (see p. 150) may be an accidental importation.

Most of these characters will be dealt with in the succeeding pages; it is only necessary here to briefly recapitulate. The characters upon which I lay stress are these—

(1) The continuous circle of setae.

(2) The (generally) undifferentiated character of the calciferous glands, which are often incompletely separated from the oesophagus.

(3) The frequent presence of two pairs of egg-sacs.

(4) The general existence of copulatory glands which are possibly the forerunners of the spermiducal glands.

(5) The existence of a series of small sacs along the septa, which may be the remains of a continuous series, of which some have been differentiated into the sperm- and egg-sacs.

Some of these characters are shared with members of the family Acanthodrilidae and Cryptodrilidae; but it is not an easy matter to distinguish these three families as has already been pointed out. Arguments of nearly—but in my opinion not quite—equal value might be put forward for placing either of the two remaining families of the Megascolides in the position of most primitive earthworm. The distribution of the Cryptodrilidae is obviously much like that of the Perichaetidae; that of the Acanthodrilidae seems to be not sufficiently world-wide to use it as an argument for the archaic nature of these worms. If all the Perichaetidae had the racemose form of the spermiducal glands, which I believe to be secondarily derivable from the tubular form characteristic of the Acanthodrilidae and many Cryptodrilidae, it would militate against their being regarded as the most primitive group. The Acanthodrilidae it will be remembered have occasionally (*Plagiochaeta*) continuous circles of setae; the fact that the majority have lost this arrangement is, in my opinion, a further argument against regarding the Acanthodrilidae as at the base of the series of earthworms. It is no doubt an exceedingly difficult matter to adjust the conflicting claims of the Perichaetidae, Cryptodrilidae, and Acanthodrilidae, to the position of the most primitive family in the group.

With regard to other earthworms, there would seem to be no doubt that the Eudrilidae and the Geoscolicidae are closely connected, and that the latter are intimately related to the Lumbricidae. The arguments for these statements are put forward in the *résumés* which I give below of the structural characters of the several groups. The question now to be considered is the relation which they bear to the group Megascolides, and their relative position with regard to each other in the phylogenetic scheme.

Rosa and others have placed the Eudrilidae, with some or all of the Cryptodrilidae, in one family; this position seems to me to be quite untenable. The Eudrilidae differ

from all Megascolides in a number of important points, of which the following are the most important:—

(1) The spermathecae, if present, are in the neighbourhood of the female gonads; they are always accompanied, and generally replaced, by coelomic sacs, which apparently perform the same function.

(2) The sperm-ducts always open into the glandular part of the spermiducal glands.

(3) The spermiducal glands open by a terminal copulatory chamber.

(4) Both paired and unpaired calciferous glands exist, or they are replaced by peculiar structures of probably a different function.

(5) The ovaries are nearly always involved in coelomic sacs.

(6) The nephridia are always paired, and sometimes form a network in the skin.

There seems to be no doubt that the remarkable development of coelomic spaces, which is so characteristic a feature in the organization of the Eudrilidae, is a secondary development. But, on the other hand, the group shows certain primitive features. This is particularly the case with the spermiducal glands, which show, in the possession of a terminal copulatory chamber, a close agreement with the copulatory glands from which they are, in my opinion, derivable. As a rule, there are no traces of these glands other than the spermiducal glands in the Eudrilidae; but MICHAELSEN has described and figured in *Reithrodrilus minutus* something which appears to be of the same nature. Mainly on account of the frequent presence of such glands in the Geoscolicidae, and the absence in them of coelomic spaces surrounding the genitalia, I should be disposed to regard that family as more primitive than the Eudrilidae.

The relation of the Geoscolicidae to the Megascolides is not a very near one, and it is furthermore not an easy task to decide which of the three families of the Megascolides has most claims to have given rise to the Geoscolicidae. The Perichaetidae may, I think, be dismissed from consideration. The only positive point of resemblance is in the intestinal caeca of *Urobenus*, which not only are like those of *Perichaeta*, but occur in the same segment. In no Perichaetous worm are the setae ornamented; this is one of the most general characters of the Geoscolicidae; nor are there any segments in the anterior part of the body in *Perichaeta* free from setae; this is another character often met with in the Geoscolicidae. It is among the Cryptodrilidae that all the characters distinctive of the Geoscolicidae occasionally occur; in *Deodrilus* we have ornamented setae and an absence of setae from the most anterior segments of the body. The long sperm-sacs of the Geoscolicidae (such as occur in *Trichochaeta*, *Pontoscolex*, &c.) have their counterpart

in *Typhaeus*. The presence of additional glands behind the spermiducal glands, and corresponding to the copulatory glands of the Geoscolicidae, is met with in *Dichogaster*. A good many of these characters, it will be observed, particularly the last, are also found in the Acanthodrilidae. In fact, it seems to be probable that the Geoscolicidae were given off from the main stem of the Megascolides, before the latter had become differentiated into the three families which now exist. As to the phylogenetic relationships of the different families of Microdrili among themselves, something appears to be clear, but a good deal is dark. I have associated together, and given my reasons for doing so, the Lumbriculidae, Tubificidae, and Naidomorpha. There appears to be a fairly straight line down from the Lumbriculidae, through *Phreodrilus* and the Tubificidae, to the Naidomorpha; and there is a gradual change in structure which favours the view that that has been the course taken.

The Lumbriculidae have the simplified muscular layers of the body-wall found in the forms lying below them, but the setae are all of the Lumbricid pattern, and are not by any means always cleft at the free extremity. They have retained the two pairs of sperm-ducts, and the spermiducal glands are less modified than in the majority of the Tubificidae. In *Phreodrilus* we get the first stage in the development of capilliform setae and the commencing reduction of one pair of spermducts. In the Tubificidae the bifid form of seta, occasional in the Lumbriculidae, has become definitely established.

On the other side, it seems to me that the relations between the Lumbriculidae and the Moniligastridae and Phreoryctidae indicate the derivation of the former from a group more akin to the purely terrestrial Oligochaeta. The Moniligastridae and Phreoryctidae seem to be offshoots from the Lumbriculid stem, before the complicated structure of the body-wall necessary to a terrestrial Annelid had been lost. Granting the relationship of all these families, which I have argued above, their relative position seems to me to be that which I have just indicated.

The question of the relations of the Enchytraeidae is a very difficult one.

They are unique among the Microdrili in possessing dorsal pores and salivary glands, the existence of which features recall of course the Megadrili. 'Their aspect and habits are largely those of the earthworms,' remarks VAILLANT (**6**, p. 226). The considerable number of segments which separate the spermathecae and the testes is another character highly suggestive of the earthworms.

On the other hand the Enchytraeidae present us with resemblances to the group of worms which lies at the opposite extreme of the Oligochaet series. They offer certain points of similarity to the genus *Aeolosoma*. These are: (1) pores instead of tubular oviducts; (2) a cardiac body in the dorsal vessel of certain species, of

which traces exist in *Aeolosoma;* and (3) the development of the clitellum (in *Mesenchytraeus* at any rate) laterally and ventrally, but *not* dorsally; (4) origin of dorsal vessel from a perienteric sinus.

Together with these resemblances to other groups of Oligochaeta, the Enchytraeidae are to be distinguished by certain peculiarities restricted to themselves. These are: (1) the peculiar form of the nephridia[1]; (2) the generally elongated and glandular funnel of the sperm-duct; (3) the reduced size and simple structure of the spermiducal glands; (4) the frequent presence of a double layer of longitudinal muscles.

These four classes of facts in the organization of the Enchytraeidae appear to me to refer them to an isolated position between the two stems of origin of the Oligochaeta.

The Enchytraeidae perhaps resemble Phreoryctes more than any other group of the higher Oligochaeta; these resemblances, however, are not numerous, and are confined to a few species. The most striking is the existence in various species of *Pachydrilus* of the segmentally arranged lateral outgrowths of the nerve-cord; structures similar to these appear to occur in *Phreoryctes.* Besides *Phreoryctes,* the only Oligochaet in which there are four setae per segment, implanted singly, is *Enchytraeus monochaetos.*

The next point to be considered is the connexion between the Microdrili, the Megadrili, and the Aphaneura. In attempting to frame the broad outlines of a phylogenetic scheme, such as is implied in the question here raised, regard must be taken of the relationships of the Oligochaeta as a whole to other groups of animals. A proper phylogenetic scheme can only be elaborated after considering these relations.

The Oligochaeta are almost universally regarded as nearly akin to the Polychaeta; the two groups are in fact generally placed within one larger group called the Chaetopoda. In so placing them it appears to me that important differences have been lost sight of, and too much stress has been laid upon the broader points of resemblance. What are the chief likenesses between the Polychaeta and the Oligochaeta? They are both regularly segmented worms, with a well-developed coelom, also arranged in accordance with the segmentation; each segment has typically a pair of nephridia, which may in both cases be secondarily increased in number; they have chitinous setae derived from the epidermis; in both there is a closed vascular system, much complicated, and usually containing red blood, coloured so by haemoglobin; in both the gonads are proliferations of the coelomic epithelium, and are persistently unenclosed in special cavities, except in a few cases; the ducts for the carrying away of the genital products are formed out of metamorphosed nephridia; lastly, the nervous system is constructed on a similar plan.

[1] I do not refer so much to the network formed by the lumen, which is to be found elsewhere, e.g. *Chaetogaster,* as to the general form of the organ.

It is undoubtedly the case that no other group than the Polychaeta comes nearer to the Oligochaeta in these essential features of organization. The Hirudinea, however, are quite as close, now that we know of the curious modifications of the reproductive organs in the Eudrilidae, and the frequently unpaired condition of the generative pores in that group and elsewhere; a commencing division of the coelom, carried much further in the Hirudinea, is to be recognized in a few earthworms.

The Gephyrea are further away still; yet in a few points they come nearer to the Oligochaeta than does any other group of worms; for example, we have in *Echiurus*, at the tail end of the body, circles of setae (as in *Perichaeta*); and the 'respiratory trees' are to some extent paralleled or foreshadowed in the anal nephridia of *Octochaetus*.

The chief differences between the Polychaeta and the Oligochaeta are as follows:—

(1) The testes and ovaries are limited in the Oligochaeta to a definite and small number of pairs[1], whereas in the other group they are much more abundant and are as a rule of one kind only in one individual.

(2) The ducts for carrying away the genital products attain in the Oligochaeta to a specialization and variety quite unparalleled in the Polychaeta; in the latter (Capitellidae, Saccocirridae, Alciopidae), they are but slightly metamorphosed nephridia.

(3) The nephridia of the Polychaeta are histologically very different from those of the Oligochaeta; the only special resemblance between the two is in the nephridia of the embryo. And these nephridia it will be observed, recall those of the Platyhelminthes.

(4) The setae of the two groups are different in form; both, it is true, have long acicular setae; but when there is any peculiarity in form it is different in the two; and the long setae are closely paralleled by those of the Brachiopoda.

These differences are not unimportant as it appears to me; the question of the near relationship between the Oligochaeta and the Polychaeta has been prejudiced by the general term 'worm,' which has been applied to these and to so many other animals having even a more remote relationship. In the same way the Crustacea and the Insects have been confounded together owing to certain obvious similarities. The Insects are distinguished mainly by the possession of tracheae, which are totally different from any structures met with in the Crustacea; so the Oligochaeta are

[1] See, however, above, where the very frequent occurrence of numerous gonads in *Lumbricus* is referred to.

distinguished by the clitellum, and by other appendages of the reproductive system, which have not their counterpart in the Polychaeta [1].

Only one group of Oligochaeta shows any particular resemblances to the Polychaeta, and that is the group represented by the genus *Aeolosoma*. There is no doubt that this Annelid does come very close in certain respects to some of the lower Polychaeta. It resembles them in the following points:—

(1) In the presence of ciliated pits on the side of the head, found also in *Saccocirrus*, *Ctenodrilus*, and *Polygordius*, &c.

(2) Ciliation of the prostomium, characteristic of *Ctenodrilus*, *Saccocirrus*, *Protodrilus* (general ciliation of body), &c.

(3) Nervous system retains its primitive connexion with the skin.

(4) Coelom divided up by irregular muscle-fibres, as in *Saccocirrus*.

(5) Testicular products carried off by very slightly metamorphosed nephridia, as in *Saccocirrus*, Capitellidae.

(6) Setae often all acicular as in some Capitellidae.

In other respects *Aeolosoma* is an undoubted Oligochaet. It has the distinctive clitellum (feebly developed, however) and spermathecae of that group. On the whole it appears to me necessary to place *Aeolosoma* near to the base of the Oligochaet series. I am not, however, at all certain whether it would not be more in accord with the anatomical facts at our disposal to place *Aeolosoma* among the Archiannelida. If then *Aeolosoma* stands at the base of the series, is it necessary to derive the other Oligochaeta from this genus? Before attacking this problem it is requisite to bear in mind that *Aeolosoma*, in spite of its primitive characters, is in some respects a degenerate worm [2]. The absence of the ventral nerve-cord is undoubtedly a mark of degeneration; so, too, is the almost complete absence of intersegmental septa; there is at most a single septum present (see p. 178). The persistent connexion of the brain with the epidermis may be also rather due to degeneration than to the inheritance of an archaic character. The colourless blood, and lastly the small size are facts which appear to me to point in the same direction. These facts still further increase the difficulty of fixing the position of *Aeolosoma* in the Oligochaet series. The two families to which it appears to come nearest are the Naidomorpha and the Enchytraeidae. The resemblances, however, are not close to either. Both

[1] EISIG considers the modification of the epidermis at the generative pores of the Capitellidae to be comparable to the Oligochaet clitellum. I should rather compare it to the glandular modification which surrounds the external aperture of the sperm-ducts in *Lumbricus*.

[2] In this connexion I may be perhaps allowed to quote E. MEYER (Biol. Centralbl. x. p. 296) to the effect that asexual reproduction only occurs in undoubtedly degenerate forms, or, in those where sexual products abound in the posterior, as well as the anterior part of the body.

the two groups mentioned agree with *Aeolosoma* in having no oviducts; in all three groups the ova are evacuated by pores or by a pore; but in the Enchytraeidae there seem to be traces of the former existence of a proper oviduct; fringes of cells along the coelomic apertures of the oviducal pores seem to indicate the former existence of proper oviducts; the resemblance, in fact, may be more apparent than real; as to the Naidomorpha we have but little information as to the exact nature of the oviducal pores. With the Enchytraeidae *Aeolosoma* agrees in the origin of the dorsal blood-vessel from a periintestinal sinus, and also in the presence of a cardiac body; traces of this seem to occur in *Aeolosoma tenebrarum*; the same structure is found in *Ctenodrilus*. Compared with the differences, the resemblances thus indicated are but slight; there is really no group of Oligochaeta with which *Aeolosoma* has well-marked affinities; I do not, therefore, think it unreasonable to place *Aeolosoma* far away from the other Oligochaeta, a derivative of the Annelid stock before it had thoroughly differentiated into the two groups, Polychaeta and Oligochaeta. I should leave it aside, in fact, in considering the origin of the remaining groups.

As to these remaining groups, they are undoubtedly all nearly connected; divisible though they are into Microdrili and Megadrili, there are no fundamental differences of structure. It is, in fact, perhaps a little doubtful into which division *Moniligaster* should go. We may, therefore, fairly consider them together with three possible conclusions in view: (1) that both Megadrili and Microdrili are derivable from a common stock; (2) that the Megadrili have been derived from the Microdrili; and (3) that the reverse mode of development has occurred.

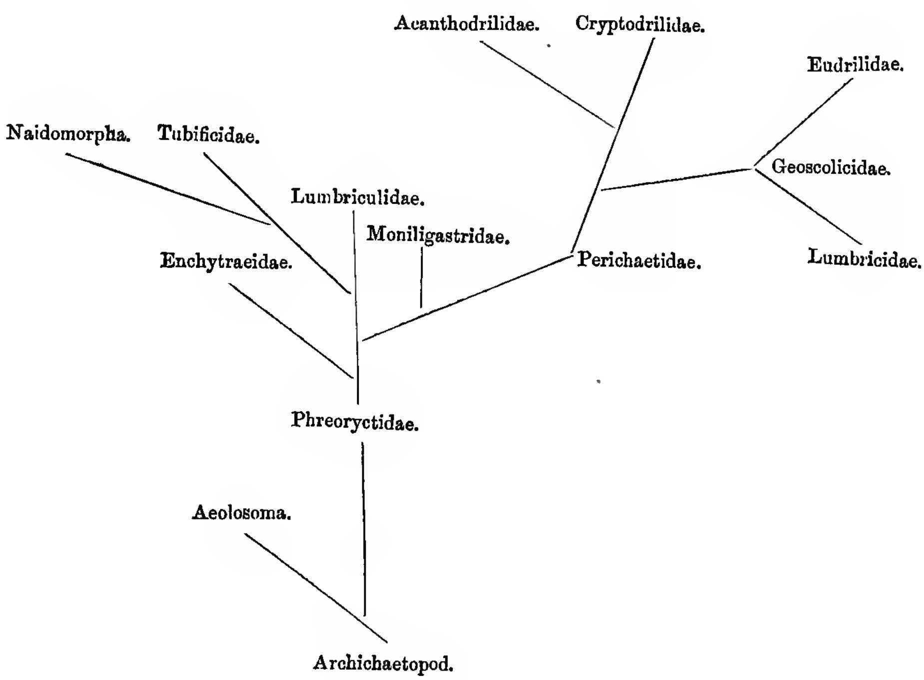
First, as to structural characters which may fairly be regarded as indicating a low position; it is necessary to carefully eliminate those characters which may be due to degeneration; it would be absurd, for example, in my opinion, to consider *Perichaeta hilgendorfi* a primitive *Perichaeta* on account of the fact that it has no spermiducal gland, present in nearly all the other species of the family; no doubt the presence of this gland is a secondary character; but in the particular case under consideration its absence must be secondary. One naturally turns to the reproductive organs for a clue to the difficulties of phylogeny. Considering that the reproductive ducts are developed from the nephridia of successive segments (in *Octochaetus* at any rate), it might be fairly supposed that the closer the correspondence between the ducts, the more primitive would be the characters of the worm; the differences between the male and female ducts must, one would think, be secondary. Judged by this standard, *Phreoryctes* would have to be placed in the position of the most archaic form of Oligochaeta; it is particularly worthy of note, in connexion with this matter, that the male-ducts of *Phreoryctes*, although longer than, and

therefore, to that extent, different from, the female-ducts, graduate into them; the anterior pair of ducts in fact are longer than the second pair; the latter, it is true, are longer than the oviducts, but still they form a transition to them. The absence of spermiducal glands here seems to me to be really a primitive character. There are other facts, too, in the structure of the reproductive organs which argue in favour of the primitive characters of the Phreoryctidae; I have pointed out elsewhere that in the embryo *Lumbricus* and *Octochaetus* there are four pairs of gonads, of which only three come to maturity; in certain species of *Perichaeta* there are two pairs of egg-sacs, corresponding to the presumably ancestral two pairs of ovaries; now in *Phreoryctes*, at least in *P. smithii*, there are actually two functional pairs of ovaries and oviducts. The development of *Octochaetus* seems also to distinctly favour the view that the primitive form of generative duct is that which only occupies two segments; the external pore being on the segment following that which contains the funnel. In the development of that Annelid the ducts in question ran straight to the body-wall, and there ended; how the further growth was effected I had no facts to enable me to judge. Besides, apart from the actual facts of development, the necessity of assuming an early correspondence between the male and female-ducts would lead to the assumption that the short male-ducts were the most primitive; there is no Oligochaet known in which the female-ducts occupy more than one segment; whereas there is every possible variation in the number of segments occupied by the male-ducts; this of itself makes it probable that the female-ducts represent the earlier condition. All arguments, therefore, appear to me to point to the conclusion that *Phreoryctes* is, in respect of its reproductive organs, the most primitive type. The vascular system of the Annelid is also in a primitive condition, though not more so than that of the Tubificidae. The development of *Lumbricus* (VEJDOVSKY) shows that a perivisceral trunk in each segment of the body is the primitive condition; apart altogether from the facts of development, this would seem to be on a priori grounds likely; we know, too, that the reduced number of the commissural vessels in the Naids is derived from a more primitive condition, in which there was a perivisceral arch in each segment (see below). In this respect *Phreoryctes* is primitive; it is true that in one species of the genus, at any rate, the perivisceral are not continuous round the body; but they are in *P. smithii*.

There is no type in fact, in my opinion, which has such good claims to occupy a low position among the Oligochaeta as *Phreoryctes*. It will be remembered also that this genus is one which was placed by LANKESTER in a position intermediate between the 'Limicolae' and the 'Terricolae' of CLAPARÈDE; it does undoubtedly

combine the characters of those two groups, which are substantially the same as the Microdrili and the Megadrili of the scheme advocated here. It is also a form which, as regards habitat, is on the border-line between the two divisions; it lives both in the water and on the land. I look upon *Phreoryctes* as representing, more nearly than any other existing form, the common type whence the Megadrili and the Microdrili have been derived. The recognition of this worm, as occupying the most primitive position in the two groups, seems to be at variance with the assumption supported above of the Perichaetidae being a primitive type on account of the continuous circles of setae. The question is whether it is conceivable that the perichaetous condition could have twice been reduced to the condition of four groups of setae; this may perhaps be a little difficult of conception; but the necessary alternative is that from the eight setae per segment the perichaetous condition has been at least twice independently arrived at. The one hypothesis is to my mind at least as difficult as the other. In conclusion, the following scheme embodies the result of the foregoing remarks.

Fig. 34.



DESCRIPTIONS OF GENERA AND SPECIES.

[*Earthworms of Unrecognizable Position.*—In the succeeding pages a number of species are dealt with, originally described under the generic name of *Lumbricus*, but really referable to other families or genera. A few forms remain which are undoubtedly earthworms, but which cannot be referred, even with probability, to any family. These species are the following:—

Lumbricus capensis[1] (KINBERG), *L. helenae* (KINBERG), *L. hortensiae* (KINBERG), *L. rubrofasciatus* (BAIRD 3), *L. vineti* (KINBERG), *L. apii* (KINBERG), *L. pampicola* (KINBERG), *L. tellus* (KINBERG), *L. tahitanus* (KINBERG), *L. juliformis* (BAIRD 3), *L. guildingi* (BAIRD 3).

The genus *Eurydame* of KINBERG is regarded by VAILLANT as synonymous with *Titanus* (=*Geoscolex*). As a matter of mere guess work, for VAILLANT'S suggestion is nothing else, I should rather prefer *Anteus* or *Rhinodrilus*. *Eurydame insignis* has the setae more separate posteriorly than anteriorly; it is a small worm from Panama 58 mm. in length. *Hegesypyle hanno*, KINBERG is from Port Natal and is only 28 mm. in length. There are eight setae per segment, separated posteriorly; anteriorly the ventral are closer than the dorsal. Is this possibly my *Acanthodrilus capensis?*

Helodrilus oculatus, HOFFMEISTER.

H. oculatus, W. HOFFMEISTER, Die bis jetzt bek. Art. Regenw., p. 39.

This is an extremely mysterious species, neglected by ROSA in his recent revision of the Lumbricidae, and, therefore, probably not believed by him to be a Lumbricid. Its most remarkable structural peculiarity is a pair of eye-spots on the buccal segment. There are four pairs of setae in each segment, which are straight instead of curved and said to be black; the male-pores are upon the fifteenth segment. The body is elongate and pink in colour; the length at most 135 mm. It occurs on the sea shore in pools more or less dried up.

VAILLANT (6, p. 168) suggests that this worm is probably a Tubificid, on account of the presence of eye-spots, and on account of its habitat. The *black* setae are very suggestive of what I have myself observed in *Tubifex rivulorum*. But it does not seem to me that we are justified in relegating the genus to any family at present.

[1] Certainly not a *Lumbricus*. I have examined, by the kindness of Prof. LOVEN, KINBERG'S type; but such was the condition of the worm that I can only mention the fact that the gizzard is situated far forward, which is not a character of the Lumbricidae.

Hypogaeon hirtum, SAVIGNY.

H. hirtum, J. C. SAVIGNY, Syst. d. Annel., p. 104.

The chief peculiarity of this species, which was met with in the environs of Philadelphia, is the *nine* parallel rows of setae. These setae are described as long, covered with spinelets, particularly upon the clitellum, where their distribution is described as confused. This suggests my genus *Trichochaeta*; but this suggestion is not supported by the position of the clitellum (xxvi–xxxix), the male-pores (?) on xv and the spermathecal pores (?) on x, xi, xii; it is impossible even to guess at its position.

Hypogaeon atys, KINBERG, might belong to any family; it has eight setae per segment and is 32 mm. long.

Another doubtful form, concerning whose position in the system nothing positive can be said, is:—

Alma nilotica, GRUBE.

Alma nilotica, GRUBE, Arch. f. Naturg., 1855, p. 129.

Digitibranchus niloticus, LEVINSEN, Vidensk. Meddel., 1889, p. 321.

I do not give any systematic description of this worm, since its position in the series is very doubtful. GRUBE, its original describer, does not give sufficient particulars to permit of a certain opinion as to its relations, but compares it with *Rhynchelmis* ('*Euaxes*'). The illustration (GRUBE **3**, Pl. v, fig. 11) represents a worm of the thickness and length of a moderately-sized earthworm, its measurements are given as 3–6 inches. During life it was, according to RÜPPEL'S notes, who was the discoverer, red coloured; it was found in the Nile mud. The most remarkable peculiarity of the worm is the possession of branchial processes upon the posterior segments of the body; it is the presence of these structures which have led most writers to exclude it from the Oligochaeta altogether, or, at least, to consider its Oligochaetous affinities doubtful. As we are now acquainted with three undoubted Oligochaeta (viz. *Chaetobranchus*, *Hesperodrilus*, and *Branchiura*) with branchiae, there is no longer any reason, on these grounds, to refuse admittance to *Alma* among the Oligochaeta. LEVINSEN'S *Digitibranchus niloticus* must, in my opinion, be regarded as generically, as well as specifically, identical with *Alma nilotica*; it was described from a fragment only, but so far as this fragment enables one to judge there are no differences from the worm described by GRUBE.

The branchiae occupy the last sixty segments of the body (as in *Branchiura*), they lie just above the dorsal pair of setae; they are small cylindrical processes with rounded extremities, and there are several of them (five or six) upon each side of the body; occasionally two or more arise from the same base. The setae are strictly paired, and according to LEVINSEN'S figure (**1**, fig. 5), are exactly like the peculiar setae of *Siphonogaster* (see below). There is not much information in GRUBE'S paper about the internal characters, but the vascular system seems to be, from what he says, comparable to that of an Oligochaet. The existence of a vascular system at all is, as Dr. EISIG has pointed out[1], fatal to a comparison with the Capitellidae; *Alma* has been compared by SIMROTH[2] with the Capitellid genus *Mastobranchus*, to which it certainly bears not a little resemblance; but neither *Mastobranchus* nor any other Capitellid possess a vascular system.]

[1] 'Die Capitelliden.' Fauna u. Flora des Golfes von Neapel.

[2] Die Entstehung der Landthiere: Ein Biologischer Versuch, Leipsic, 1891, p. 236.

Group APHANEURA.

Family AEOLOSOMATIDAE.

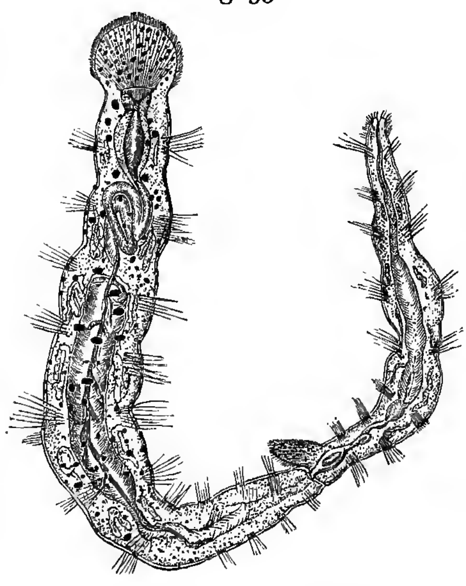
As there is only one certainly known genus, viz. *Aeolosoma*, I do not attempt a definition of the family.

Genus Aeolosoma, Ehrenberg.

Syn. *Aeolosoma*, Ehrenberg. *Aeolonais*, Gervais. *Chaetodemus*, Leidy.

Definition. **Freshwater Oligochaeta of small size; segmentation not marked by regular septa; prostomium ciliated ventrally; setae in four bundles of one to six setae each, usually capilliform (only sometimes both capilliform and sigmoid). Clitellum developed only on ventral side of segments v–vii; testis single in v; ovary single in vi; no differentiated sperm-ducts; oviduct a ventral median pore in vi. Spermathecae in some or all of segments iii–iv. Nervous system represented by cerebral ganglia only. Lateral ciliated pits present.**

Fig. 35.



AEOLOSOMA EHRENBERGI.

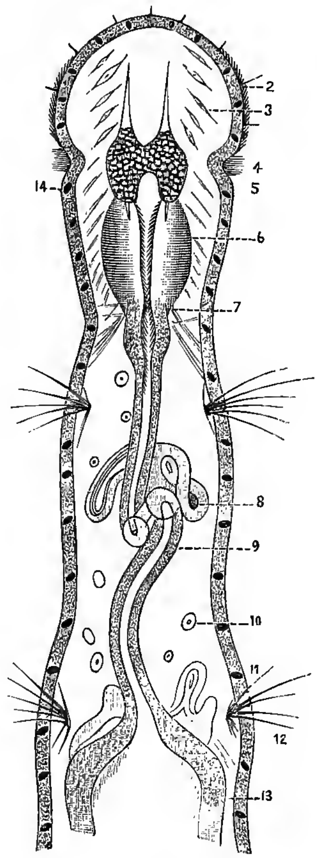
(After Lankester.)

A chain of two individuals.

This genus comprises a few species which are distributed over Europe, W. Asia, N. Africa, N. America, Central America, (New Granada), India, and Africa, in fresh water. They are all of small size, the largest species, *A. tenebrarum*, reaching a length of only 10 mm. They are transparent worms, with a very 'loose and uncertain outline, the body flowing in various directions in a very strange liquid fashion.' The segmentation is not very marked externally, except by the implantation of the setae. When an *Aeolosoma* is fully extended the head segment is separated from the next by a constriction. The number of segments in an individual is small, not more than a dozen to fifteen. The prostomium is large, and is ciliated upon the under surface; on either side are a pair of ciliated pits, which are

probably sense-organs; they lie close to the brain, and in front of the mouth-opening. The setae are, in all the species of the genus except three, capilliform; they are implanted in bundles, of which there are four to each segment; each bundle contains a varying number of setae, of varying sizes, from two to nine; the number of setae in the breadth is, in some cases at least, a character of specific importance. The only species in which there is any specialization of the setae are *A. tenebrarum*, *A. niveum*, and *A. leidyi*; the posterior segments of these species have ʃ-shaped setae, which may or may not be bifid at tips. The body generally, and the prostomium especially, has minute, hair-like, rigid processes, which may be of a tactile nature[1].

Fig. 36.



AEOLOSOMA, HEAD END.

(After Vejdovsky.)

2. Cilia on under surface of prostomium. 3. Muscular cells. 4. Ciliated pit. 5. Brain. 6. Pharynx. 7. End of pharynx. 8. First pair of nephridia. 9. Oesophagus. 10. Coelomic corpuscles. 11. Second pair of nephridia. 12. Setae. 13. Intestine. 14. Coloured oil-globule in skin.

The *epidermis* is covered by an excessively thin cuticle, only recognizable (according to VEJDOVSKY) after treatment by reagents. The cells of the epidermis are of two kinds; there are more columnar cells, among which lie large, round, glandular cells. On the ventral surface of the prostomium the ciliated cells are figured by LEIDY (**6**, Pl. ii. fig. 11) and VEJDOVSKY (**24**, Pl. i. fig. 36) with a hexagonal contour. The gland-cells are of two kinds, coloured and colourless. The coloured epidermic gland-cells are highly characteristic of the genus; they are found in every species of this genus, and *Ctenodrilus*, which is possibly an ally of *Aeolosoma*. Their colour varies according to the species; they are red-brown in *A. quaternarium*, &c., olive green in *A. tenebrarum*, bright green[2] in *A. varium*, and bright green with a bluish tinge in *A. headleyi*. The colour is due to a large drop of oily substance within the cell; that this drop is of a fatty nature appears to be shown by its black staining with osmic acid. The pigment itself is probably closely related, in spite of its difference of hue, in all species; I have shown (**32**, **74**) that

[1] VAILLANT (**6**) states that there are cilia over the general body-surface. This, however, is contrary to the statements of other authors and to my own observations; the cilia are limited to the prostomium and to just behind mouth.

[2] The green colour suggests chlorophyll; ZACHARIAS has recently suggested that the 'oil-globules'

in three species it is turned into a beautiful violet by the action of alkali; it is dissolved out and destroyed by alcohol[1]. Colourless gland-cells appear to be particularly abundant in *A. variegatum*, and to be the only ones present in *A. niveum*. There can be no doubt that the coloured (and colourless) oil-globules form the contents of cells similar to those found in the epidermis of the Oligochaeta. LEIDY (**6**), it is true, has spoken of them as nuclei either of the hexagonal cells of the prostomium or of the muscle-fibres of the body-wall; but this is undoubtedly an incorrect opinion. The cells, however, which contain these bodies have, according to VEJDOVSKY, no nuclei; so far as regards *A. hemprichii* I have been able (**32**) to confirm him, but not as regards *A. tenebrarum* (**74**), where the nuclei are not difficult to see. However, they are present in the developing cells of *A. hemprichii;* in such cells the coloured body first appears as a minute droplet, which gradually grows, pushing the nucleus to one side; the nucleus seems to be itself converted into oil (VEJDOVSKY).

The *muscular layer of the body-wall* is very delicate. LEIDY (**6**, Pl. ii. figs. 8, 9, 12) figured a single layer only of circular fibres. VEJDOVSKY with difficulty, and then only occasionally, detected a delicate circular layer of fibres; the longitudinal layer also exists, and I have figured both in *A. headleyi* (**68**, Pl. xii. fig. 2 *m*, *m'*). *Aeolosoma* is therefore in this respect a typical Oligochaet. The *coelom* is not divided by intersegmental septa into a series of segments; one segment only, the first, is bounded by a distinct septum. Nevertheless, the body-cavity is traversed by muscular fibres which extend between the alimentary tract and the parietes; and serve to keep the former in position. This statement applies no less to *A. quaternarium* and *hemprichii* than to other species. The fibres in question are nucleated, the nucleus lying in an oval swelling of the fibre at about its middle. They have been figured by VEJDOVSKY (**24**) and by myself (**68**). In the cavity of the prostomium, and in the section of the body-cavity round the pharynx, they are more numerous and closely set than elsewhere. There is occasionally a branching and anastomosis of the individual fibres. Similar unicellular muscular fibres (BEDDARD **68**, Pl. xii. fig. 3) are attached to the sacs of the setae, and serve to move them; it is interesting to find that the muscles which connect together the seta-bundles of the same segment are histologically different; these strands (BEDDARD **68**, Pl. xii. fig. 3 *sm*) consist of exceedingly fine fibrils, closely set together, and with no visible nuclei. These latter muscles appear to be absent

are really symbiotic algae; he observed them dividing. I believe that I have shown (**74**) that it is not chlorophyll.

[1] In *A. tenebrarum* a solution of iodine produces a remarkable effect; a dense black colouration spreads over the *outside* of the oil-globule, which as rapidly disappears; this effect was only seen in living cells. For further remarks on the pigment of *Aeolosoma* I may refer to my two papers upon the subject (Nos. **32**, **74**).

in certain species of *Aeolosoma*. The coelom is of course lined by peritoneum, and contains a few round corpuscles, which vary in number at different times. There are no dorsal-pores and no head-pore; the coelom, however, communicates with the exterior by the

Nephridia. These organs are paired and metamerically arranged. They commence at earliest behind the first bundles of setae; we might possibly, therefore, consider that they belong to the third segment, were it not for the position of the funnel; the definite location of the nephridia is, however, rendered impossible by the absence of the septa separating the segments; VEJDOVSKY considers that the first pair of nephridia belong to the second (i. e. the first setigerous) segment. In this case the entire nephridium is confined to a segment, for the funnel does not perforate the only existing septum, that dividing segments i and ii. The fact that the external pore of the nephridium (in *A. headleyi* at any rate) lies in advance of the funnel[1] is a further confirmation of VEJDOVSKY'S suggestion. In *A. variegatum* the first nephridium is in segment iii. The nephridium is attached by a delicate muscular band to the gut; each is a much-coiled tube, with granular nucleated walls. STOLC has figured (**1**, Pl. vii. fig. 4 *a*) a peritoneal covering of transparent vesicular cells; the ciliated funnel is composed of very few cells; it is hardly wider than the tube which follows. Just before the external pore, which lies ventrally in front of, and to the inside of, the ventral setae-bundles, the nephridium dilates into a clear-walled vesicle, which VEJDOVSKY states to be contractile, and to be filled with a clear fluid.

During sexual maturity some of the nephridia, as Dr. STOLC discovered (**1**), disappear; the others, particularly those of the sixth segment, convey the sperm to the exterior; in the sixth segment one nephridium only is figured by STOLC (**1**, Pl. vii. figs. 2, 3 *e c h*); this is larger than the rest, and the funnel, instead of facing backwards, as in the other nephridia, faces forwards. It also appears to be shorter.

VEJDOVSKY discovered that in the buds of *Aeolosoma* the first segment is provided with a pair of provisional nephridia. These organs were chiefly studied in *A. tenebrarum*; they are most evident in the head segment, before the pharyngeal ingrowth has taken place, while the gut is still continuous from the parent worm to the bud; they lie closer to the gut on either side, and each consists of a thick-walled, hollow sac, of a pear-shaped outline; the narrow end of this sac is attached to the dorsal body-wall, but no orifice leading to the exterior could be discovered; nor is there any coelomic aperture. They disappear on the invagination of the pharynx.

[1] STOLC, on the other hand (1), figures the funnel as in advance of the external pore; the relative position of the two, however, undergoes constant change owing to the movements of the worm.

The *alimentary canal*, which is ciliated throughout, may be divided into a pharynx, an oesophagus, and an intestine; the pharynx occupies the first segment of the body; in the young worm, budded off from the parent, the pharynx appears as an epiblastic involution; it is lined by cubical, ciliated cells, and has a layer of circular fibres. In *A. tenebrarum* the hinder margin of the pharynx gives rise, on either side, to a small, thick-walled diverticulum, to which the last of the muscular bands supporting the pharynx are attached. Following upon the pharynx is a narrow oesophagus, occupying two or three segments, and commonly furnished at its commencement with an oval dilation. The intestine is wide to begin with, and gradually narrows towards the terminally-placed anus. The structure of the intestine and oesophagus is exceedingly simple; the walls of the tube consist of a cubical, ciliated epithelium, outside which is a peritoneal layer; between the two, in the intestine, is interpolated a vascular network or sinus (see p. 73), and the dorsal blood-vessel lies underneath the peritoneal covering of the oesophagus.

The *vascular system* is exceedingly simple. It consists merely of a dorsal and ventral trunk, which are united in the anterior part of the body; the dorsal vessel is usually only recognizable in the oesophageal region, where it forms a pulsatory tube, not, however, lying freely in the body-cavity, but beneath the oesophageal peritoneum; anteriorly this vessel behind the brain divides into two trunks, which reunite to form the ventral vessel; in a few examples of *A. hemprichii* VEJDOVSKY observed a pair of vessels given off from the cephalic ring, which, he believes, rejoin the dorsal vessel. Behind the oesophagus there is no dorsal vessel; it ends here in a network of blood-vessels, ramifying in the walls of the intestine, beneath the peritoneal coat. The ventral vessel, on the other hand, lies perfectly free in the body-cavity; anteriorly it is, as already mentioned, in communication with the dorsal-vessel by a pair of lateral commissures passing round the pharynx. In the intestinal region it gives off a number of trunks, sometimes regularly paired, sometimes not, which join the intestinal network. This intestinal network appears not to exist in either *A. quaternarium*, *A. variegatum*, or *A. headleyi*; it is replaced in those species by a paired blood-sinus[1]. Proper walls to the blood-vessels have not been clearly demonstrated. Blood-corpuscles have, however, been found by EICHWALD, MAGGI[2], and VEJDOVSKY, but only in the dorsal vessel. In several species there is a row of somewhat fusiform cells in the dorsal vessel, which have yellowish fat-drops in their interior; I have suggested (**4**) that these cells probably represent a rudimentary dorsal organ

[1] I say 'paired blood-sinus' in deference to VEJDOVSKY; in *A. headleyi* (see my figure **68**, Pl. fig. 6) the sinus did not seem to be paired, but to be continuous all round the intestine.

[2] The corpuscles described by MAGGI are, however, probably coelomic.

such as is found in the Enchytraeidae. The colour of the blood-plasma of *A. hemprichii* is stated by LANKESTER (**6**) to be of a pinkish colour.

The *nervous system* consists of little else than the cerebral ganglion. The simplest cerebral ganglia are those of *A. variegatum*, where the fissure indicating its double nature is hardly visible; in *A. tenebrarum* it is most complicated, with well-marked lateral lobes; this species also alone shows any traces of a ventral nerve-cord, which is very short and is not connected with the brain. The latter is perfectly continuous with the epidermis, and is composed of cells dorsally and of nerve-fibres ventrally (*A. variegatum*) or of cells only; it gives off numerous branches. VEJDOVSKY throws considerable doubt upon MAGGI'S description of a ventral cord in *A. hemprichii*, which is not accompanied by any figures.

Generative organs. The generative organs of *Aeolosoma* have been described by D'UDEKEM (**2**), MAGGI, and more recently, as well as more fully, by STOLC (**1**). The reproductive organs are only occasionally developed, the usual mode of reproduction being by budding and division. Curiously enough, sexual and asexual reproduction may be, according to D'UDEKEM (**2**) carried on *pari passu*. MAGGI'S figure of the ovaries and oviducal pores (fig. 8) is, it should be observed, an almost exact copy of that of D'UDEKEM (**2**, fig. I); in another figure, however, he supplements D'UDEKEM by illustrating the spermathecae, which were apparently not seen by D'UDEKEM. All these observers appear to have investigated the same species, viz. *A. hemprichii* and *A. quaternarium*. The testis is median and unpaired, and lies in the fifth segment; the ovary occupies a corresponding position in the sixth segment. As has been already mentioned, there are no sperm-ducts, the nephridia, particularly that of the sixth segment, which is slightly different in structure from the rest, serving as conduits of the sperm. The ova, which are few and large, and apparently undergo amoeboid movements, escape by a large pore on the ventral surface of the sixth segment. The spermathecae are small oval sacs, one to three pairs occupying segments iii–v.

At the epoch of sexual maturity a clitellum is formed, which is figured by STOLC as limited to segments v–vii; it is only developed on the ventral side of the body. It is not known whether a cocoon is formed; the structures described by EHRENBERG, and described and figured as developing eggs by MAGGI, are probably, as VEJDOVSKY (**24**) suggested, encysted worms. At any rate, I have recently been able to show (**27**) that this annelid can encyst itself. The cysts are of variable thickness, usually spherical, but sometimes oval or of irregular form. I found them at the commencement of cold weather, at the end of autumn.

The asexual propagation of *Aeolosoma* has been studied by VEJDOVSKY; the

species selected was the large *Aeolosoma tenebrarum*. The most interesting fact in this process is the entire absence of the formation of any budding zone such as exists in the *Naidomorpha* (see below). In *Aeolosoma* there is simply a division of the parent organism into two; the formation of the head of the newly-formed individual is ushered in by a dorsal thickening, which is the basis of the brain; the next event is the increase of the future head of the daughter zooid and the appearance of muscular strands. Very soon there appear a pair of provisional nephridia, such as seem always to occur in the head of the lower Oligochaeta when produced in this asexual way. It is important to observe that the pharynx is a new structure invaginated from the epidermis, and not produced by any modification of the existing section of the gut. This formation of the pharynx was also found to occur in *Aeolosoma variegatum* (see VEJDOVSKY **18**).

Species of AEOLOSOMA. The division of the genus into species is a matter of no little difficulty, on account of the very imperfect descriptions which the older authors have given. Only six species can be at present regarded as well established; four of these, viz. *A. hemprichii*, *A. quaternarium*, *A. tenebrarum*, and *A. variegatum*, have been clearly discriminated by VEJDOVSKY (**18** and **24**) one, *A. niveum*, by LEYDIG (**4**); the remaining species, *A. headleyi*, I have described myself (**68**), and believe to be distinct from any of the above. The following is a complete list of all the species which may possibly be regarded as distinct.

(1)	**Aeolosoma**	**hemprichii**, EHRENBERG.	(6)	**Aeolosoma**	**headleyi**, BEDDARD.
(2)	„	**quaternarium**, EHRENBERG.	(7)	„	**niveum**, LEYDIG.
(3)	„	**variegatum**, VEJDOVSKY.	(8)	„	**leidyi**, CRAGIN.
(4)	„	**aurigena**, EICHWALD.	(9)	„	**ternarium**, SCHMARDA.
(5)	„	**tenebrarum**, VEJDOVSKY.	(10)	„	**macrogaster**, SCHMARDA.

The following species are somewhat uncertain in position and affinities.

Two of the species described by SCHMARDA, viz. *Aeolosoma ternarium* and *A. macrogaster*, have been referred by VAILLANT to a distinct genus, *Pleurophlebs*, on account of (1) absence of coloured globules in the skin, (2) the presence of two lateral blood-vessels. These two species appear likely to prove very interesting, but their structure requires, in my opinion, a re-examination before they can be admitted.

Aeolosoma pictum of SCHMARDA (from New Granada) has red oil-globules and a spiral intestine; it is very doubtfully distinct from one or other of the red-coloured species, *A. quaternarium* or *A. hemprichii*.

Aeolosoma chlorostictum of WOOD MASON is only known by a name; he referred to it incidentally in describing an infusorian parasite.

VOELTZKOW has recorded from Madagascar an *Aeolosoma* with 'golden-yellow' oil-drops, but no further information is given.

Aeolosoma stokesii of CRAGIN with 'salmon-coloured nuclei' is probably either *A. quaternarium* or *A. hemprichii.*

A number of other names, which have been applied to supposed species, will be considered under the descriptions of the species with which they are probably identical.

(1) Aeolosoma hemprichii, EHRENBERG.

A. hemprichii, EHRENBERG, Symb. Phys. 1831.
A. decorum, " " "
A. ehrenbergi, OERSTED, Naturhist. Tidskr. 1842, p. 135.
A. balsamo[1], MAGGI, Mem. Soc. Ital. Sci. Nat. 1865, p. 9.
A. quaternarium, LANKESTER, Trans. Linn. Soc. 1867, p. 641.
Chaetodemus multisetosus, CZERNIAVSKY, Bull. Soc. Nat. Mosc. 1880, p. 307.

Definition. *Head broader than the following segment. Setae nearly straight; longer and shorter ones in the same bundle. Integumental globules orange-red to dark crimson. Supraoesophageal ganglion divided posteriorly into two by deep fissure. Nephridia commence in first setigerous segment. Intestine surrounded by a network of capillaries. Localities—England, Europe, N. Africa.*

If all the species which have received the above names are really one, it is clear that, as VAILLANT has pointed out, the first of EHRENBERG'S two names has the priority, and that OERSTED had no right to introduce the new name '*ehrenbergi.*' The synonomy of the species however is difficult. I include *A. balsamo* in deference to the high authority of Prof. VEJDOVSKY, who was evidently influenced in this identification by the large size of the head as figured by MAGGI. In the latter 'species,' however, MAGGI figures the setae of the lateral bundles as longer and more numerous than those of the ventral bundles. If this character were established it would undoubtedly be of specific value. LANKESTER'S *A. quaternarium* is certainly identical with VEJDOVSKY'S *A. ehrenbergi*, though it is regarded by VAILLANT as synonymous with *A. quaternarium* of EHRENBERG. This is apparently because of the error (?) in LANKESTER'S illustration, which shows the prostomium to be of equal or less diameter than the body. The comparatively large size of the worm, and the presence of nephridia in the first setigerous segment, as well as the form of the setae (straight), and the presence of an intestinal network prove that LANKESTER'S *A. quaternarium* is wrongly identified by VAILLANT.

[1] Corrected to '*Balsamoi*' by Czerniavsky.

(2) Aeolosoma quaternarium, Ehrenberg.

A. quaternarium, Ehrenberg, Symb. Phys., 1831.

A. venustum, Leidy, Journ. Acad. Nat. Sci. Philad. Vol. II (1850), p. 46.

A. italicum, Maggi, Mem. Soc. Ital. Sci. Nat. Vol. I (1865), p. 8.

Chaetodemus quaternarius, Czerniavsky, Bull. Soc. Nat. Mosc. 1880, p. 307.

Definition. *Head equal in breadth to following segments. Setae sharply bent; those in each bundle of the same length. Supraoesophageal ganglion divided into two posteriorly by deep fissure. Integumental globules orange-red. Oesophageal segments without nephridia. Intestine surrounded by a paired blood-sinus. The worm can temporarily encyst itself. Localities—England, Europe, N. America.*

This is quite a distinct species from the last, as will be seen on comparing the definitions. *A. italicum* was incompletely, and possibly erroneously, described by Maggi. If correctly described in all particulars it should be referred to a distinct species, characterized by having only *one* pair of bundles to each segment instead of *two* pairs—each bundle containing only ten setae. The small prostomium and the small size of the worm are the chief reasons (I presume) which led Vejdovsky to place it as a synonym of *A. quaternarium.* It is not clear why Vaillant regards *A. italicum* as synonymous with *A. hemprichii.* In Maggi's paper the 'eggs' of *A. italicum* are described and figured. Vejdovsky suggested that these, being surrounded by a capsule, were cocoons, but remarked later (**9**) that it was not certain whether the structures in question were really cocoons or encysted worms. That the latter suggestion was probably correct was shown by myself (**27**), and by him (**2**). The cysts are usually regularly spherical, rarely oval or of a more irregular rounded form. The cyst wall is of an appreciable thickness and is in some specimens thicker than in others. The cysts were found at the beginning of the cold weather. The formation of cysts in *A. hemprichii* is perhaps hardly an additional argument for its identity with *A. italicum*, the only other *Aeolosoma* in which they have been described. Leidy's *A. venustum* is only distinguished from *A. quaternarium*, according to Leidy himself, by its smaller size and longer setae. These characters can hardly be considered sufficient.

(3) Aeolosoma variegatum, Vejdovsky.

A. variegatum, Vejdovsky, SB. Böhm. Ges. 1886, p. 275.

Definition. *Head broader than following segments. Setae longer and shorter in the same bundle, sharply bent. Supraoesophageal ganglion only just divided by a shallow furrow*

posteriorly. Integumental globules colourless and bright-green. Oesophageal segments without nephridia. Intestine surrounded by a paired blood-sinus. Localities—Germany, Ireland.

This beautiful little *Aeolosoma* was first referred to by VEJDOVSKY, in his illustrated memoir (**24**), as probably identical with LEYDIG'S *A. niveum* (p. 113, footnote), but afterwards (**18**) regarded as a new species and fully described with illustrations. Some examples sent from Cork by Prof. HARTOG have allowed me to verify the chief points in VEJDOVSKY'S paper. It may be the same as a species mentioned by ZACHARIAS (**1**).

(4) Aeolosoma aurigena, EICHWALD.

Nais aurigena, EICHWALD, Bull. Soc. Nat. Mosc. 1847, p. 359.

Definition. *Two lines in length. Head broader than following segments. Integumental globules golden-yellow, lying close together in regular longitudinal lines. Three or four setae in each bundle. Locality—Russia.*

Whether this species is really distinct from *A. tenebrarum* is uncertain. VEJDOVSKY considers that it is chiefly on account of the regular distribution of the integumental globules. EICHWALD'S description is unfortunately defective in many important particulars which require to be known before the species can be properly defined. He describes and figures the dorsal vessel as running along the whole length of the body; but probably the ventral vessel was mistaken for the dorsal. It apparently (so VAILLANT thinks) inhabits the Baltic; this may be an additional argument for its specific distinctness from *A. tenebrarum,* which has been hitherto only obtained from quite fresh water.

(5) Aeolosoma tenebrarum, VEJDOVSKY.

Aeolosoma tenebrarum, VEJDOVSKY, SB. Böhm. Ges. 1879, p. 505 (footnote).

Definition. *Of considerable size* (5–10 *mm.*). *Head broader than following segments, and pointed anteriorly. Setae capilliform and sigmoid; supraoesphageal ganglion plainly double, with well-developed lateral lobes. Integumental globules pale-yellow to olive-green. Oesophageal segments with nephridia. Intestine with vascular network. Locality—Water from deep springs in Prague, England.*

This species is one of the largest of the genus. It has been fully described by VEJDOVSKY in two memoirs (**17** and **24**), and some details have been added by myself (**74**). Its structure is more complicated than that of any other species, and has already been for the most part described in the account of the generic characters of *Aeolosoma* given above. It is the only species except *A. leidyi* (if this is really distinct) and

A. niveum in which there are two kinds of setae. The capilliform setae resemble those of other species, but the sigmoid setae are peculiar to this species and to *A. leidyi* and *A. niveum*; they are like those of Naids, bifid at the free extremity; these setae are found in the dorsal and ventral bundles, from the fourth setigerous segment onwards.

It should be remarked that in the specimens described by myself under the name of *A. tenebrarum* the sigmoid setae of the posterior segments are *not* bifid. I examined them with great care and with high powers, but could not detect the least notch at the extremity of the setae. The colour of the oil globules, too, does not agree with VEJDOVSKY's description or coloured figures of *A. tenebrarum*. These worms may therefore possibly belong to a distinct species.

(6) Aeolosoma headleyi, BEDDARD.

A. headleyi, BEDDARD, P. Z. S. 1888, p. 213.

Definition. *Of moderate size; setae entirely capilliform. Integumental globules bright-green, occasionally verging towards blue. First nephridium in first setigerous segment; nine or ten pairs altogether. Habitat? (found in a tank at Zoological Gardens, London).*

This species evidently comes nearest to *A. variegatum*, but is to be distinguished by large number of nephridia.

(7) Aeolosoma niveum, LEYDIG.

A. niveum, LEYDIG, Arch. f. Anat. u. Phys. 1865, p. 360.

A. lacteum, TIMM, Arb. Zool. Zoot. Würzb. 1883, p. 155.

? **Chaetodemus panduratus**, LEIDY, P. Acad. Nat. Sci. Philadelphia, V. 1852, p. 286.

Definition. *Prostomium not wider than following segments. Setae sigmoid and capilliform. Integumental globules colourless; only one pair of nephridia, at end of oesophageal region.*

This species was described and figured by LEYDIG (**4**). It is of very minute size, apparently smaller even than *A. quaternarium* and *A. variegatum*. LEYDIG thought that it was possibly the young of '*A. decorum*' of EHRENBERG, but pointed out that this was rendered less likely by the fact that EHRENBERG observed the red-coloured oil-drops of the latter species while yet within the egg. In all probability the 'eggs' mentioned by EHRENBERG are the cysts which I have described, and thus this argument falls to the ground. VEJDOVSKY thought that his *A. variegatum* might be the same. The same form was found in the Main by TIMM, and mentioned under the name of '*Aeolosoma lacteum*, LEYDIG'—doubtless a slip of the pen. I have contributed a few notes (**25**) upon this species, pointing out the existence of sigmoid

setae. It is possibly identical with LEIDY'S *Chaetodemus panduratus*, also a transparent and colourless species. I could not myself detect even colourless oil-drops.

(8) Aeolosoma leidyi, CRAGIN.

A. leidyi, CRAGIN, Bull. Washburn Coll. Lab. vol. ii. p. 3.

Definition. *Anterior segments with capilliform and sigmoid, posterior segments with sigmoid setae only. Integumental globules pale olive-green.*

As defined, this species can be distinguished from *A. tenebrarum* by the distribution of the sigmoid setae, which, in the last-mentioned species, are only found in the seta bundles of the posterior segments.

Group MICRODRILI.

FAMILY PHREORYCTIDAE.

DEFINITION. **Aquatic or terrestrial Oligochaeta of slender form, often exceedingly long. Setae in four rows of single setae or pairs, sigmoid. Testes in X, XI. Ovaries in XII, XIII, or XIII only. Sperm-ducts, two pairs opening separately, without spermiducal glands Spermathecae in front of testes, without diverticula. No genital setae.**

This family contains at present only two genera, viz. *Phreoryctes*, which has been long known, and *Pelodrilus*, recently described by myself. As these genera, although both conforming to the above definition, present numerous structural differences, it will be better to describe them separately instead of giving a general sketch of the anatomy of the family as has been done in other cases.

Genus PHREORYCTES, HOFFMEISTER.

Syn. *Phreoryctes*, HOFFMEISTER. *Haplotaxis*, HOFFMEISTER. *Nemodrilus*, CLAPARÈDE. *Georyctes*, SCHLOTTHAUBER.

DEFINITION. **Setae in four rows of single setae or pairs. Clitellum XI–XIV. Prostomium divided by a transverse constriction. Testes in X, XI; ovaries in XII, XIII. Vasa deferentia open separately on to XI and XII; oviducts on to border line between segments XII/XIII and XIII/XIV. Spermathecae two or three pairs in VII, VIII (IX).**

This genus was originally described by HOFFMEISTER (3) under the name of

Haplotaxis, subsequently (**1**, p. 40) altered to *Phreoryctes* for the reason that *Haplotaxis* had been previously used in Botany. SCHLOTTHAUBER altered the name to *Georyctes* for the reason that the worm is not exclusively an inhabitant of 'wells,' but is occasionally found in the soil. This change cannot of course be allowed. CLAPARÈDE (**2**) applied the name *Nemodrilus* to a worm found by him in the Rhone, in ignorance of its identity with *Phreoryctes*[1]. Accordingly the name *Phreoryctes* must stand, unless, indeed, it be thought that the same name may be allowed to an animal and a plant: but in any case the name *Phreoryctes* is now so well established that it seems hardly worth while to make a change. The genus *Phreoryctes* has been found in a good many parts of Europe (not in England), and in New Zealand, and in North America.

The species of the genus are of considerable length and thinness (this is less the case with *P. smithii*), and the *prostomium* is generally divided into two by a transverse constriction—a character also met with in the Capitellidae, which were at one time, not, however, for this reason, included in the Oligochaeta. The setae in the European *Phreoryctes* are of the typical Lumbricid pattern, sigmoid and not cleft at the free extremity. As a rule there are only four setae to each segment, which are implanted singly and at equal distances from each other; each has commonly a nearly complete 'soie de remplacement' beside it. Each of these setae, together with the incomplete seta lying beside it, represents the pair of setae in other Oligochaeta. The dorsal and ventral setae are usually of different sizes. A more normal arrangement of the setae is met with in *P. smithii*, where they are distinctly paired; here, however, we still find the same difference in size between the dorsal and ventral pairs. The dorsal setae are largely obsolete in *P. emissarius*. The *clitellum* is not extensive; it occupies segments xi–xiii inclusive and a portion of segment x.

The ventral nerve-cord is provided in each segment with a peculiar appendage, first described by LEYDIG (**6**), and afterwards by TIMM and FORBES; these structures, the 'ventral organs' of TIMM, are pyramidal masses of nucleated cells which support the nerve-cord as the 'chairs' support the railway lines; they are hollowed out where the nerve-cord rests upon them. These organs are regarded by TIMM as of sensory function. Similar organs occur in the Enchytraeidae.

The most remarkable feature about the *vascular system* is that (according to CLAPARÈDE) the ventral vessel is contractile – a condition which is, so far as we are aware, unique among the Oligochaeta.

The *reproductive* system is in several respects peculiar and interesting. The

[1] This identity was first pointed out by VAILLANT (3, p. 249).

existence of *four* pairs of gonads was pointed out first of all by LEYDIG, and confirmed later by myself (**69**). I was able to show that these gonads are composed of two pairs of testes in x and xi, and two pairs of ovaries in xii, xiii. In no other Oligochaet are there more than one pair of ovaries. The ducts are interesting on account of their simplicity. Oviducts can only be distinguished from sperm-ducts by their position and smaller size. The funnel opens into one segment and the external aperture is upon the next. The second pair of sperm-ducts is shorter than the first pair, and thus offers a transition to the oviducts, which are shorter still. The spermathecae are two (*P. smithii*) or three (*P. menkeanus*) pairs, in segments vii, viii, and ix. They are simple pouches without diverticula of any kind.

The number of species of this genus is at least four; and they are all well characterized. They may be recognized as follows:—

Prostomium divided by transverse constriction	Setae paired	Comparatively stout worm. *P. smithii.*
	Setae implanted singly	Dorsal setae longer than ventral. *P. filiformis.*
		Ventral setae longer than dorsal. *P. menkeanus.*
Prostomium not divided.	Dorsal setae disappear posteriorly.	*P. emissarius.*

(1) Phreoryctes menkeanus, HOFFMEISTER.

P. menkeanus, HOFFMEISTER, Die bis jetzt bek. Art. &c. 1845, p. 40.

Haplotaxis menkeanus, HOFFMEISTER, Arch. f. Nat. 1843, p. 193.

Georyctes menkei, SCHLOTTHAUBER, Amt. Ber. Vers. deutsch. Naturf. zu Göttingen, 1854, p. 122.

Definition. *Length*, 600 *mm.*; *diameter*, 1 *mm.* *Number of segments, more than* 500. *Ventral setae longer than dorsal, both implanted singly. Habitat—Europe.*

Besides above references see LEYDIG (**6**), VEJDOVSKY (**24**), GIARD (**2**), TIMM.

(2) Phreoryctes filiformis, CLAPARÈDE.

Nemodrilus filiformis, CLAPARÈDE, Mém. Soc. Phys. Gen. 1862, p. 275.

Phreoryctes heydeni, NOLL, Arch. f. Nat. 1874, p. 260.

Phreoryctes filiformis, VEJDOVSKY, SB. Böhm. Ges. 1875, p. 198.

(?) **Georyctes lichtensteini**, SCHLOTTHAUBER, Amt. Ber. Vers. deutsch. Naturf. Göttingen, 1854, p. 122.

Definition. *Length*, 140 *mm.*; *diameter*, 1 *mm.*; *dorsal setae longer than ventral, implanted singly. Habitat—Europe.*

This species is confounded with the last by VAILLANT, although both NOLL and

Vejdovsky have pointed out its differences from *P. menkeanus.* Noll has stated that the setae of the present species are shorter (2 mm. instead of 3 mm.) and much more hooked than those of *P. menkeanus.* Noll, however, figures and describes the ventral setae as longer than the dorsal. Vejdovsky states the opposite, and Vaillant mentions an individual in which the setae were about equal, which rather casts a doubt upon the distinctness of the two species, though the length is so very different.

(3) Phreoryctes smithii, Beddard.

P. smithii, Beddard, Ann. and Mag. Nat. Hist. 1888, p. 389.

Definition. *Comparatively stout worm. Setae paired, dorsal setae, of the posterior segments, longer than ventral. Two pairs of spermathecae in VII, VIII. Habitat—N. Zealand.*

There can be no doubt about the distinctness of this species; it is of a stouter build, not so long in proportion to its breadth as are the remaining species of the genus. In the paper cited above (and in Beddard **18**) will be found such details as are known about the species. The anatomical facts have been for the most part mentioned in the description of the characters of the genus. Other points, possibly of specific importance, may be now referred to. The dorsal setae, though of the same form as the ventral, are about three times their length; the shaft of the seta which is implanted in the body wall is curved, not straight, as in the other two species. The nephridia commence, in the sexually-mature worm, in the sixteenth segment, and their external orifice is in front of the ventral pairs of setae. The worm was collected by Mr. W. W. Smith chiefly in forest pools, where it lives in association with a species of *Limnodrilus*; one example was discovered in marshy soil; so that this species is equally at home in water and in damp soil.

(4) Phreoryctes emissarius, Forbes.

P. emissarius, Forbes, Bull. Illinois State Lab. Vol. iii, 1890, p. 108.

Definition. *Long, slender species; prostomium not transversely furrowed. Setae implanted singly; dorsal setae disappear before middle of body, previously diminishing in size. Habitat—N. America.*

This species can be at once distinguished from the others by the complete absence of dorsal setae from all but the anterior seventy segments or so. This species is seven or eight inches in length and only ·6–·7 mm. in thickness, and consists of more than 375 segments[1]. The nephridia, which were found from segment x onwards, open in front of the ventral setae; the first six pairs, however, were more or less

[1] All the specimens examined by Mr. Forbes were broken.

rudimentary, and doubtless disappear when the sexual organs—concerning which there is no information—appear. The cells of the funnels are ciliated, a number of cilia to each cell. A peculiar flask-shaped gland opens behind each seta. The oesophagus extends from segments ii-iv. It appears to be a subterranean species. See also FORBES (2).

Genus PELODRILUS, BEDDARD.

DEFINITION. **Small, slender worms. Setae paired. Clitellum XI–XIII. Sperm-ducts, two pairs opening on segment XII by four separate orifices. Ovaries in XIII; oviducts opening on to border line between XII/XIII. Spermathecae one pair in VIII.**

This genus consists, at present, of only a single species recently described by myself. Although short and slender in form, and resembling a *Lumbriculus*, its affinities are clearly with *Phreoryctes*, from which genus, however, it shows certain important differences. The *nephridia* of the sexually-mature worm commence as far forward as the seventh segment, and are only absent in the eleventh and twelfth segments; they are thus present in several of the genital segments. There are two pairs of sperm-ducts, the funnels of which open into the tenth and eleventh segments; the tubes themselves are much coiled, but open on to the twelfth segment; they are distinct from each other throughout their whole course, and there are four external pores; these are situated two on each side of the body, one being in front of the other. The *clitellum*, contrary to the conditions which obtain in most aquatic Oligochaeta, is undeveloped in the ventral region. The male pores, which lie a little to the anterior of the line of the ventral setae (these setae are absent from the twelfth segment), mark the ventral boundary line of the clitellum. A series of radiating muscular fibres are inserted near the male apertures and probably servo to protrude them during copulation. There is, contrary to what we find in *Phreoryctes*, only a single pair of ovaries present, which lie in the thirteenth segment.

The genus *Pelodrilus* agrees with *Phreoryctes* in the following more or less important characters, those marked with an asterisk being the most important.

(1) Setae sigmoid and paired (*Phreoryctes smithii*).
(2) Testes in x, xi.
*(3) Sperm-ducts two pairs, all four opening separately.
*(4) Spermiducal gland absent.
(5) Spermathecae anterior to testes.
*(6) Hearts long, thin, and much convoluted.

These points taken together[1] are such as to render the inclusion of *Pelodrilus* in any other family but the Phreoryctidae impossible; the only other alternative would be to create a separate family for its reception, which appears to be unnecessary.

(1) Pelodrilus violaceus, BEDDARD.

Pelodrilus violaceus, BEDDARD, Trans. Roy. Soc. Ed. Vol. xxxvi. Pt. ii. (1891) p. 301.

Definition. *Prostomium short. Nephridio-pores in front of ventral setae. Septal glands in V–VII. Chloragogen-cells covering alimentary tract commence in V. Sensory papillae two —one behind the other—on segment X. Habitat—N. Zealand.*

As only one species of the genus *Pelodrilus* is known, the above generic and specific definitions will doubtless ultimately require revision. The species occurs in rich, wet soil, at a little distance from a swamp near Ashburton, New Zealand. In connexion with its terrestrial habit, the thickening of the integument and of the septa in the anterior part of the body (septa v/xi) is of interest.

FAMILY MONILIGASTRIDAE.

DEFINITION. Large or small earthworms, with paired setae, eight per segment; clitellum X–XIII; male pores X/XI or XI and XII; sperm-ducts open into segment in front of that which bears the external pore; spermiducal gland showing the same structure as in the Lumbriculidae, with sometimes a protrusible penis.

This family of earthworms is in many ways exceedingly remarkable; the genus *Moniligaster*—for a long time the only genus of the family—was originally made by PERRIER (**3**), its describer, into a separate group called Aclitellians, equivalent to the three other groups into which PERRIER divided the terrestrial Oligochaeta; this step was taken on account of the apparent absence of that characteristic organ the clitellum. A clitellum was, however, recognized by BOURNE (**2**) in a large species, *M. grandis*, some feet in length, where it would naturally be more obvious than in the small *M. deshayesi*; the apparent absence of the clitellum is to be probably explained by the fact that it is only periodically developed, as in the aquatic Oligochaeta; in addition to this possible explanation of the failure of most

[1] The above characters hardly differentiate *Pelodrilus* from *Lumbricus*; as, however, I am here comparing *Pelodrilus* with *Phreoryctes* there is, perhaps, hardly any need to point out the more important facts which distinguish both from *Lumbricus*.

observers to find the clitellum, may be added the fact that the clitellum, when developed, is not always very obvious when the worm is examined by a lens only, without subjecting it to microscopical investigation; as I have pointed out, recently, (**5**) the clitellum in the genus *Moniligaster* is unique among 'earthworms,' by reason of the fact that it is only one cell thick, as in the aquatic Oligochaeta, without exception. This structural fact about the clitellum, coupled with its forward position, places this family in a very isolated position among the terrestrial Oligochaeta, and undoubtedly affines them to many among the purely aquatic forms. A second remarkable feature about this family, which now includes, besides the type genus *Moniligaster*, a second genus described by Rosa, *Desmogaster*, is in the relative position of the internal and external openings of the sperm-ducts; in earthworms the funnels of these ducts are always some segments in front of the external pores; as many as eight or nine segments in certain cases; there is, it is true, a progressive series down to *Allurus* and perhaps *Tetragonurus*, where the external pores are upon the twelfth segment; the funnels are presumably in the eleventh segment, though we cannot at present be sure as to this, for the genus has not been submitted to anatomical study; in the aquatic forms, on the other hand, the funnels are never situated more than a single segment in front of that which bears the external pore; and there are even cases where the same segment contains the funnel and bears externally the pore. This is precisely what we find in the Moniligastridae; the funnel is in the tenth segment, while the external pore is upon the groove separating segments x/xi. *Desmogaster* differs from the genus *Moniligaster* in the doubling of the male organs; here the two pairs of male pores are upon segments xi and xii; the funnels of the sperm-ducts are placed in the segments in front of these. The sperm-ducts communicate with the exterior by means of spermiducal glands, four in *Desmogaster*, two in *Moniligaster*. In *Moniligaster*, at any rate, the glands resemble very closely those of the Lumbriculidae, and certain Tubificidae such as *Branchiura*; each consists of two parts—a glandular and a muscular; the glandular section is an egg-shaped sac, which receives its sperm-duct at the extremity farthest away from the external pore; it consists of a lining epithelium of low columnar cells, surrounded by a layer of circularly-disposed muscle fibres, which are again surrounded by a mass of granular, pear-shaped cells, with long prolongations perforating the muscular layer and the lining epithelium so as to reach the lumen of the gland; the distal part of the organ is chiefly muscular, with a few gland-cells interspersed among the muscles, and is reflected to form a protrusible penis, very similar to that organ as met with in the family Tubificidae. It is not quite clear from Rosa's account (**11**) how far the spermiducal gland of *Desmogaster* differs from that of

Moniligaster; a fuller description of its structure will be found on a preceding page (p. 119). The ovaries usually occupy an abnormal position—abnormal, that is to say, as compared with 'earthworms,' where they are invariably in the thirteenth segment; this statement, however, only applies to certain species of *Moniligaster*, where the ovaries occupy segment xi; in *Desmogaster* and in *M. houteni* and *M. viridis* their position is different; they lie in xiii; there is of course a corresponding difference in the apertures of the oviducts.

The Moniligastridae have very large egg-sacs—another point of resemblance to many 'Limicolae;' as a general rule the fact that these structures, which extend through several segments, are egg-sacs depends upon probability; their position is such as to lead to the inference that that is their nature; in *M. bahamensis*, however, the egg-sacs were found by me (**57**) to contain numerous ova; these ova were not particularly large, a little larger than is common among earthworms but nothing like the bulk of the enormous ova of the Tubificidae or Lumbriculidae. Nevertheless they were crammed with large yolk particles, so much so as to frequently obliterate the nucleus; this fact may be an important point of similarity to aquatic Oligochaeta; but it must be admitted that it may only point to the conclusion that the egg-sacs are not meant to store the ova but are merely the receptacles of useless ova, which there undergo degeneration. There are other facts which render this latter conclusion possible (see p. 96). In any case the large size of the receptacula ovorum is, as I have pointed out, and as Rosa (**11**) has admitted, a resemblance to the freshwater Annelids.

The family Moniligastridae is characteristically an old-world group; it has been met with in India, Ceylon, Sumatra, Borneo, Burmah; quite recently, however, I have described a species from the Bahamas.

The affinities of the family are not so plain; I have dwelt upon the resemblances to the aquatic Oligochaeta—a resemblance which Rosa has sought to minimize. In the following points the genus *Moniligaster* differs from earthworms and agrees with the lower Oligochaeta:—

(1) The sperm-ducts only traverse one septum on their way to the exterior, and are much coiled, as in *Pachydrilus* for example. The doubling of the sperm-ducts in *Desmogaster* is not important, for this often occurs.

(2) The spermiducal gland and the penis are constructed upon the plan common to many 'Limicolae,' and different from that found in any 'earthworm.' This does not altogether apply to *Desmogaster* (but see p. 119).

(3) The forward position of the male-pores.
(4) The minute structure of the clitellum and its forward position.
(5) The large size of the egg-sacs, and the great abundance of yolk in the ova.

Even if we follow ROSA in placing but little stress upon the shifting forward of the clitellum and the male-pores, there remain a number of facts in the anatomy of the Moniligastridae which indicate differences from all other earthworms, and similarities to the lower Oligochaeta.

BENHAM (**1**) places the family upon the direct line of evolution of the higher from the lower Oligochaeta, thus admitting their affinities to the latter. I have already discussed the way in which this evolution has most probably taken place, viz. in the reverse direction from that believed in by BENHAM; but there still remains the question to which group of the higher Oligochaeta are the Moniligastridae most nearly related. ROSA (**20**) suggests the Geoscolicidae and Lumbricidae; but is not able to bring forward many facts in support of this contention. The principal matter upon which he dwells, in comparing the family to the Geoscolicidae, is the intersegmental position of the male-pores; the presence also of caeca to the nephridia is referred to, though this is also met with among the Acanthodrilidae; but it is thought by ROSA that there are also affinities in this latter direction. As regards the Lumbricidae he compares the Moniligastridae chiefly with *Allurus* and *Tetragonurus*; this comparison is made on account of the forward position of the male-pores; the posterior gizzards are also mentioned as a point of similarity to the Lumbricidae; but we now know that more than one genus belonging to quite different families have the same character, viz. *Pleionogaster*, and *Hyperiodrilus*, &c., among the Eudrilidae. The forward position of the male-pores may well be, as ROSA thinks, a reason for associating the family Moniligastridae with the Lumbricidae; but it is surely not quite fair to deny this point of likeness to the Lumbriculidae, &c., and to claim it for the Lumbricidae! On an earlier page of his paper dealing with *Desmogaster* (**11**), in which these matters are subjected to a renewed discussion, ROSA quotes the example of *Buchholtzia appendiculata* to discount the strength of the arguments derived from the forward position of the clitellum in *Moniligaster*.

Other points of resemblance to the Geoscolicidae hardly exist[1], and it does not seem that the mere position of the male-pores is a likeness of first-rate importance; the only conclusion to which we can, in the present state of our knowledge, come is that the Moniligastridae form an isolated group, with general affinities to the

[1] Ornamented setae have been found in so many groups; but it must be admitted that they are characteristic of the Geoscolicidae. In the present family they occur in *M. houteni*.

lower Oligochaeta, but with no particular resemblance to any one family of these or of the higher Oligochaeta. The family, as already mentioned, contains two genera, *Moniligaster* and *Desmogaster*. These two genera are at any rate generally recognized; it is, however, a matter for consideration whether *Moniligaster* should not be again subdivided into two genera; two species, viz. *M. houteni* and *M. viridis* (if they be really distinct) agree in the following points:—

(1) The spermiducal glands are long.

(2) The ovaries are in segment xiii.

Probably *M. deshayesi* belongs to this group, though the incomplete information respecting these points which is given by PERRIER does not allow of any certainty in the matter.

On the other hand, all the remaining species, of whose anatomy we have anything like a complete account, show the following assemblage of characters:—

(1) The spermiducal glands are round or oval.

(2) The ovaries are in segment xi.

I am inclined to think that a few more characters could be added to these; possibly the protrusible penis of *M. bahamensis* and *M. indicus* are among those characters.

I do not, however, venture here to divide the genus *Moniligaster*, as accepted, into two genera, since we are as yet in ignorance of the characters of the considerable numbers of species, briefly recorded by BOURNE (**2**), from India.

Genus MONILIGASTER, PERRIER.

DEFINITION. **One pair of testes, sperm-sacs, and sperm-ducts, the latter opening between X/XI; ovaries in XI or XIII; spermatheca usually in VIII, with long duct; three to five gizzards; a protrusible penis sometimes present.**

There has been a great deal of discussion as to the actual facts in the anatomy of this genus, let alone the conclusions to be drawn from the facts. The original description given by PERRIER (**3**) was in some respects inaccurate, as has been subsequently shown by myself (**19**), HORST (**1**), and ROSA (**11**). PERRIER thought that the worm possessed two pairs of male-ducts and pores; the mistake arose through his having confounded the spermathecae with an anterior pair of spermiducal glands.

There has been also some confusion as regards the position of the various organs —a confusion which is still, perhaps, hardly dissipated. For the observations of HORST (**1**), upon a large species of the genus from Sumatra, seem to show that the

male-pores are a segment behind those of the other species; it is, however, not to my mind certain that there is not an error of one segment, and that *M. houteni* agrees with the remaining species of the genus in the position of the male-pores between segments x/xi. Rosa (**20**), arguing from the preconceived idea that *Moniligaster* would be found to present the typical characters of earth-worms, suggested that Horst's determination was probably right; but at that time I had fixed the position of the apertures in question as lying between segments ix/x, a position which I subsequently stated to be an error; as a matter of fact, the setae of the first setigerous segment (the second) are so very small in *M. barwelli* that I at first overlooked them; in *M. bahamensis* they seem to have vanished altogether. Rosa's own investigations upon *M. beddardii* (**11**), and those of Benham upon *M. indicus*, confirmed this location of the male-pores.

The alimentary system of *Moniligaster* is remarkable for the fact that there are at least three gizzards, which lie in as many consecutive segments at the end of the oesophagus; the oesophagus is rather wide in calibre, and has no trace of any calciferous pouches; there does not even appear to be any vascular part of it, such as apparently does duty in so many earth-worms for the otherwise missing glands, except apparently in *M. japonicus*.

The reproductive organs consist of (1) a single pair of testes in segment x, depending from the anterior wall of this segment; they are enclosed within the (2) sperm-sacs; the sperm-sacs in *M. barwelli*, lie partly in the ninth and partly in the tenth segment; in *M. bahamensis* and, apparently, in *M. houteni* they are restricted to the tenth segment; in *M. viridis* they lie in the eleventh; their cavity is broken up by trabeculae in *M. indicus*, but not in the species investigated by myself, and they completely envelop the testes, as already mentioned, and (3) the funnels of the sperm-ducts; the latter belong, therefore, to the tenth segment, and lie in the same segment as that which bears the external pore of the sperm-ducts—a very unusual state of affairs; the sperm-ducts are, when fully mature, long and much coiled; their appearance, indeed, as I have already pointed out, suggests the sperm-ducts of the Enchytraeidae; these coiled ducts lie partly in the tenth and partly in the ninth segments; it may be that this peculiarity is confined to the species, *M. bahamensis*, in which I have described it; but it seems more likely that is not the case, but that the sperm-ducts, when the animal is fully mature, have the same great length. (4) The sperm-ducts open into a spermiducal gland, which consists of two parts; the distal part is a sac which has very muscular walls, and of which the epithelium is reflected over a protrusible penis—precisely like that of the Tubificidae; into this opens a sac with a lining of

epithelium, surrounded by a layer of circular muscles, which is itself surrounded by a layer of large pyriform cells, whose prolongations penetrate the muscular and epithelial layers to communicate with the lumen of the organ; near to the summit of this glandular part of the organ opens the sperm-duct. (5) The ovaries are generally in the segment which follows that containing the testes; the oviducts lie opposite to them, and, therefore, open on the exterior between segments xi/xii; a most characteristic feature of the genus (and of the closely allied *Desmogaster*), viz. the large egg-sacs has been already spoken of. (6) The spermathecae are a single pair only; they usually lie in the eighth segment; each consists (except in *M. japonicus*) of a small globular pouch communicating with the exterior by an extraordinarily long duct, which has well-marked muscular walls. It is not an easy task to discriminate the various species of *Moniligaster* which have been described; altogether the following thirteen species have received names:—

(1) **Moniligaster deshayesi**, E. P., Ceylon.
(2) „ **barwelli**, F. E. B., Manila.
(3) „ **houteni**, Horst, Sumatra.
(4) „ **japonicus**, Mich., Japan.
(5) „ **bahamensis**, F. E. B., Bahamas.
(6) „ **indicus**, Benham, India.
(7) „ **beddardii**, Rosa, Burmah.
(8) „ **grandis**, Bourne, India.
(9) „ **uniquus**, Bourne, India.
(10) „ **sapphirinaoides**, Bourne, India.
(11) „ **robustus**, Bourne, India.
(12) „ **papillatus**, Bourne, India.
(13) „ **ruber**, Bourne, India.
(14) „ **minutus**, Bourne, India.

Seven of the species in the above list are too imperfectly known to admit of their being defined in a way sufficient to discriminate them from those that are known.

Moniligaster grandis appears to possess five gizzards (in segments xvii–xxi); the septum between segments ix/x is missing; but Benham throws some doubt upon this fact, and explains it by the shifting of the septa, which does take place elsewhere.

Moniligaster uniquus has gizzards in xv–xix and is a small species.

Moniligaster sapphirinaoides has gizzards in the same segments as *M. grandis*, but appears to be a smaller form.

Moniligaster robustus has the gizzards in an unusually anterior position, viz. in segments xi–xv.

Moniligaster papillatus is chiefly defined by 'long tubular papillae in connection with the pores

between somites x and xi'; I imagine that these papillae are in all probability the extruded muscular penis, in which the spermiducal gland of several species terminates. The gizzards are in xvi–xx.

Moniligaster ruber has a more restricted gizzard than in any other species—it is only found in segments xiii, xiv; but in segments x–xii there are 'soft-walled swellings of the intestine, looking like gizzard only not muscular.'

Finally, *Moniligaster minutus* has a gizzard extending through segments xii–xiv only; it has large egg-sacs reaching from the twelfth to the fifteenth segment.

The species that are sufficiently known, for systematic purposes (including a form described for the first time in the present work) may be thus distinguished:—

	LENGTH.	GIZZARDS.	LAST PAIR OF HEARTS.	SPERM-SACS.	SPERMIDUCAL GLANDS.	PENIS.	OVARY.
M. deshayesi . .	150 mm.	6 & 13–22 (5)	in ix		long and bent	?	
M. barwelli . .	28 mm.	13–15 (3)	in xiv	in x (?)	short	absent	in xi
M. indicus . .	137·5 mm.	in 13–16 (4)	in ix	in ix	short	present	in xi
M. bahamensis .	25 mm.	13–15 (3)	in ix	in x	short	present	in xi
M. houteni . .	1050 mm.	15–22 (4)	in xi	in xi	long	?	in xiii
M. japonicus . .	28 mm.	12, 13 (2)	?	in x (?)	?	?	?
M. viridis . . .	350 mm.	15–18 (4)	in xi	in xi	long and bent	absent	in xiii

(1) Moniligaster deshayesi, Perrier.

M. deshayesi, Perrier, Nouv. Arch. Mus. 1872, p. 130.

Definition. *Length, 150 mm.; breadth, 6 mm. Alimentary canal with a gizzard in VI and four gizzards in XIII–XXII; hearts in VI–IX. Hab.—Ceylon.*

This species is the type of the genus; but unfortunately it is not very clear if it be really different from some of those described by Bourne. The existence of a gizzard in the sixth segment in addition to the gizzards which lie posteriorly is, so far as can be said at present, the distinguishing character of the species; but the absence of an anterior gizzard in all the remaining species of the genus renders the supposed presence of this gizzard in *Moniligaster deshayesi* perhaps just a little doubtful; the specimen examined by Perrier was in a poor state of preservation; hence it is possible that an error has been made.

The description of this species is illustrated by a number of figures; these are not all quite intelligible in the light of our present knowledge; it is above all not clear as to the 'anterior pair' of male efferent organs (Fig. 79): the structures termed by Perrier 'the glands of the seventh segment;' their minute structure is figured as well as described, and I am still disposed to think that my suggestion that these are the dilated extremities of the spermathecae, while the duct

'entortillé comme serait un Gordius' is the long spermathecal duct, is correct; the bodies termed by PERRIER ovaries are evidently the egg-sacs; they are figured as containing ripe ova.

PERRIER states that the spermathecal orifice is on a line with the ventral pairs of setae; this is possibly an oversight. The spermatheca itself is furnished with a pair of large stalked glands. I have suggested that these are comparable to the diverticula of the spermatheca so common among earthworms. With this suggestion BENHAM agrees, but makes the additional remark that they correspond to the bilobed sac which he discovered at the end of the spermatheca in *Moniligaster indicus;* this appears to me to be a reasonable view to take.

The sperm-duct is figured and described by PERRIER as possessing a quantity of little leaf-like bodies attached to it; these can be nothing else than the folds of the sperm-duct, which in this, as in other species of the genus, is extremely convolute. The spermiducal gland of this species is rather unlike that of others; it is long and is bent upon itself near to the summit, the two parts running parallel; but they are not, as in *Moniligaster viridis*, of equal length; one part is not so much as one-half the length of the other; the sperm-duct is represented as joining the gland at the point where it bends upon itself.

(2) Moniligaster barwelli, BEDDARD.

M. barwelli, BEDDARD, Ann. and Mag. Nat. Hist. 1886, p. 94.

M. beddardii, ROSA, Ann. Mus. civ. Genova (2a), Vol. ix, p. 379.

Definition. *Length, about 30 mm.; alimentary canal with three gizzards in XIII–XV; septa V/IX thickened; sperm-sac lying half in segment IX and half in segment X. Hab.—Luzon, Burmah, Flores.*

This species is one of the few which are adequately characterised; it was originally described by myself, and was at that time the second species of the genus, the only other being *M. deshayesi*. HORST has pointed out that my *M. barwelli* is probably identical with ROSA's (**11**) *M. beddardii*. With this identification I fully agree; there are no differences that can be found in the descriptions given by ROSA and by myself of our two species. ROSA distinguished his *M. beddardii* from my *M. barwelli* in the following details:—In *M. beddardii* there are only three gizzards; in my earlier description of *M. barwelli* I stated that there were four of these, but I subsequently corrected that statement. My figure of the sperm-funnel misled ROSA into thinking that these two organs differed in the two species. As to the colour which ROSA had used to distinguish the two, I am not of opinion that much weight can be attached to that difference.

I am doubtful whether to include in this species a small *Moniligaster* described in some detail by HORST from the island of Flores. The specimen was only 18 mm. in length, and it appears to possess a protrusible penis; I should not, however, like to assert positively that *M. barwelli* does not possess this organ; I have indeed

suggested that the presence of a penis may prove characteristic of one group of this genus. As to the large size of the egg-sacs in HORST's species, that may be merely a question of more complete maturity.

(3) Moniligaster houteni, HORST.

M. houtenii, HORST, Notes from Leyd. Mus., IX, p. 97.

Definition. *Length, I. 50 M.; breadth,* 18 *mm.; number of segments,* 443: *gizzards* (4) *in XV–XXII; septa, VI/X, XXIII/? thickened; spermiducal glands open, XI/XII; spermathecae in IX; ovaries in XIII. Hab.—Sumatra.*

This species comes nearest to *M. viridis;* under the description of the latter most of the points of resemblance as well as of difference are noted. *M. houteni* is quite the largest *Moniligaster*, and is indeed one of the largest of earthworms. HORST has described and figured the setae as being ornamented with ridges after the fashion so very prevalent in the Geoscolicidae. It will be noticed from the definition that the aperture of the spermathecae has moved a segment further back in correspondence with that of the spermiducal glands; but while the latter glands lie in the same segment as they do in *M. viridis*, the spermathecae are a segment further back; the sperm-sacs are in the eleventh segment; they are described as being large flat pale-brown organs, in which however only Gregarines were recognized; there is no doubt however that they are the sperm-sacs. It seems clear from HORST's description that the two septa enclosing the ovaries join together peripherally as they do in *M. viridis;* this arrangement, which must facilitate the passing of the ova into either the oviduct or into the egg-sacs, is not commonly to be found among earthworms.

In a subsequent note upon this worm (**17**), HORST reaffirms the position of the male pores, and states that they are in line with the dorsal setae, and not between the two pairs.

(4) Moniligaster japonicus, MICHAELSEN.

M. japonicus, MICHAELSEN, Arch. f. Nat. 1892, p. 232.

Definition. *Length,* 28 *mm.; breadth,* 3 *mm.; number of segments,* 95; *alimentary canal, with two gizzards in XII, XIII; spermathecae without a long duct. Hab.—Japan.*

This species is clearly distinct from any of those that are well characterized; it has been somewhat briefly described by MICHAELSEN, his description not being illustrated by any figures. The above definition contains, I think, all the points in which this

species differs from others. The length of the egg-sacs may, however, be a further difference; MICHAELSEN states that they occupy segments xii–xvi, with a little doubt. The spermathecae are a little further back than is usual in the genus; they open between segments ix/x; in having no stalk they differ from the spermatheca of other species. The ovaries also appear to be somewhat unusual in their size; they reach from septum x/xi to xi/xii, and are only deficient above the oesophagus. In the large size of the ovaries the species resembles *M. viridis.*

(5) Moniligaster bahamensis, BEDDARD.

M. bahamensis, BEDDARD, Proc. Zool. Soc. 1892, p. 690.

Definition. *Length, 25 mm., three gizzards in XIII–XV; septa V/IX thickened; sperm-sac lying entirely in X. Hab.—Bahamas.*

This species is mainly interesting on account of the fact that it comes from the New World, and is at present the only member of the family with that origin. It is a rather more slender species than *M. barwelli,* but otherwise seems to agree fairly closely with it. The apparent differences concern the spermatheca and the penis. In *M. barwelli* I did not find a protrusible sac connected with the spermathecae or with the spermiducal gland, such as exist in the present species and in *M. indicus;* but their apparent absence may, after all, be only a question of a less degree of maturity. It is mainly the habitat which leads me to distinguish this species from the other one mentioned. The same remark applies also to *M. indicus,* though there is here the further difference that there are four gizzards. I imagine that I have made an error in placing the spermathecal pores in a position corresponding to the interval between the dorsal and ventral setae.

This is the only species in which the structure of the clitellum and of the ripe ova has been seen. The ova are remarkable for the fact that they are filled with yolk spherules, though they are not markedly larger than those of other earthworms; the structure of the clitellum agrees with that of the aquatic Oligochaeta in consisting of a single row of cells only. These points, however, are in all probability of generic or family importance, and have accordingly been treated of as such. I mention them here as a matter of history.

(6) Moniligaster indicus, BENHAM.

M. indicus, BENHAM, Q. J. M. S., Vol. xxxiv, p. 361.

Definition. *Length,* 137·5 *mm.; number of segments,* 150 *(about); gizzards in XIII–XVI;*

septa VI/IX thickened slightly; sperm-duct perforates body-wall on its way to spermiducal gland. Hab.—Nilgiris, India.

This species is, thanks to BENHAM'S researches, one of the best known. It comes near to *M. barwelli* and *M. bahamensis*. Like that latter species, it has a protrusible muscular sac, connected both with the spermatheca and with the spermiducal glands. The latter are bound down to the parietes by a few muscular strands—a state of affairs which recalls the similar glands in the Geoscolicidae and certain Eudrilidae.

The sperm-duct runs for a part of its course in the thickness of the body-wall; this occurs also in the species *M. viridis*, but has not been noticed elsewhere; there are other worms in which the sperm-duct has this rather unusual course, which belong to so many different groups that it cannot be of importance as indicative of any affinity (see p. 100). The interior of the sperm-sacs are divided up by trabeculae; though they appear to be suspended in the septum which divides segments x/xi, they are seen in sections to lie really in segment x, the wall of which bulges back at the place where the sperm-sac is attached to it. The muscular sac in which the spermathecal duct ends is remarkable for lying in two segments; it is in consequence bilobed, but the spermathecal duct enters it exactly in the middle between the two lobes.

(7) Moniligaster viridis (NEW SPECIES).

Definition. *Length, 350 mm.; breadth, 18 mm.; number of segments, 186; gizzards in XV–XVIII; spermiducal glands long; egg-sacs in XIV, not extending beyond this segment. Hab.—Borneo, Penrisen Hills, Sarawak.*

Of this new species I have been able through the kindness of Mr. EVERETT to examine a couple of specimens. It appears to be a perfectly distinct new species, coming nearest to *M. houteni;* it resembles that species in the fact that the ovaries are two segments further back than they are in all others. There are, however, several points in which *M. viridis* differs from *M. houteni;* the most obvious difference is perhaps in the fact that the spermiducal glands are bent upon themselves so that the two ends are in actual contact; the reason for this is that the sperm-duct after leaving the sperm-sac passes straight down to the ventral body-wall, and there perforates the muscular layers of the body-wall, only emerging to enter (after a short course) the summit of the spermiducal gland; in *M. houteni* HORST has figured (**1**, fig. 1) the glands as lying straight, and he expressly compares them to those of *Acanthodrilus*, which are not bent upon themselves in the way

that those of *M. viridis* are. In other respects it must be admitted that the present species comes very near to *M. houteni*.

A remarkable point about it is its colour. What this may have been during life I do not know; but after preservation in alcohol it is dark green above, with a very abrupt demarcation between this and the yellowish of the ventral surface. BENHAM has commented upon a similar plan of coloration in *M. indicus*.

The dorsal vessel showed indications of being double in segment xi, a fact which is also noted by HORST for *M. houteni;* the last pair of hearts were in the same segment.

The thickened septa show the same very peculiar arrangement that appears to characterize *M. houteni;* there are a set of thickened septa in the anterior segments, and another set behind the gizzards. The septa in question are vii/xi and xix/xxv. The two septa enclosing the thirteenth segment meet laterally, so as to form a closed compartment.

The sperm-sacs are large and rounded; they lie in the same segment as that in which the spermiducal glands lie; they are almost spherical in shape, with a long and narrow neck connecting them with the septum x/xi. The sperm-ducts are not much coiled; they pass, as has already been described, from the interior of the sperm-sacs to the ventral body-wall, which they perforate, as in *M. indicus;* but emerge sooner to enter the spermiducal gland. The latter have an appearance like that of the corresponding glands of *Diplocardia communis* (see below); they are marked by rounded spots, which are in reality the masses of glandular cells which form the outer layer of the organ; the gland ends in the body-wall, without undergoing any apparent change in its structure.

The ovaries are large, and lie in the thirteenth segment; they extend on to the dorsal surface of the gut, and are suggestive rather of a gland connected with the gut than of the ovaries, which a microscopical examination of their contents showed them to be. The egg-sacs are also large, but they do not extend even as far as the posterior wall of the fourteenth segment, to the anterior septum of which they are, of course, attached; they open by a wide mouth into the cavity of the thirteenth segment, opposite to the ovaries; projecting from this mouth was a curious structure, having the appearance of a mass of fine tubes, closely branching and anastomosing; a good deal of the egg-sac itself was also lined with a similar mass of tubes, which are clearly blood-vessels; the closeness and complexity of this tuft of vessels is, possibly, an indication that the egg-sacs have the capacity for growth, and that they may, when the worm is perfectly adult, have the same extent as in *M. houteni*.

Genus DESMOGASTER, ROSA.

DEFINITION. Two pairs of testes and efferent ducts opening XI/XII, XII/XIII; ovaries in XIII.

This genus is at present only certainly known by one species, *D. doriae*. Its anatomy has been carefully worked out by ROSA (**11**). The principal differences from *Moniligaster* are indicated in the above definition of the genus; they mainly concern the doubling of the male apparatus. The sperm-ducts lie in two segments, the funnel lying in the segment in front of that which bears the pore belonging to it. The single spermatheca is, as in *Moniligaster*, to be found in segment viii.

There is a peculiarity in the vascular system, which may, possibly, be of generic value; the two last pairs of hearts—those lying in segments x, xi—appear to be double. The outer vessel is the larger, and is sinuous in its course; the inner vessel closely embraces the oesophagus. At its origin the outer vessel, which is the true heart, communicates with the inner by a short branch; the inner vessel communicates, above the oesophagus, with its fellow of the opposite side, but has no direct communication with the dorsal vessel; they end in two lateral vessels, which run along the body-wall.

(1) Desmogaster doriae, ROSA.

D. doriae, ROSA, Ann. Mus. civ. Geneva (2 a), IX, p. 369.

Definition. *Length* 500 *mm.; breadth* 12 *mm.; number of segments*, 330. *Septae VII/XI, greatly thickened; last pair of hearts in XI; ten gizzards, commencing in XX. Hab.—Meteleo, Burmah* (1000–1400 *M. in height*).

(2) Desmogaster horsti, BEDDARD.

D. sp., HORST, Zool. Ergebn. Max Weber, III. p. 49.

Definition. *Length* 140 *mm.; number of segments nearly* 300; *septa VII/X thickened; eight gizzards, commencing in XVII. Hab.—Sumatra, Mt. Singalay.*

This appears to me to be a distinct species, by reason of the fact that it has only eight, instead of ten, gizzards. HORST also mentions that the sperm-ducts do not open into the spermiducal glands at their summit, as is the case with *D. doriae*. HORST is inclined to think that the tenth septum is absent.

SUPERFAMILY LUMBRICULIDES.

This group includes the families Naididae, Tubificidae, and Lumbriculidae.

VAILLANT (6) united the two first of these families into one; the chief distinction drawn between them by D'UDEKEM was the fact, that in the first asexual propagation by budding takes place—a phenomenon quite unknown in the Tubificidae. VAILLANT is disinclined to allow that this is a distinction of first-rate importance, and I agree with him. In the first place, among the parallel group of the Polychaeta, the forms which multiply by budding are not in every case very widely separated from those which do not exhibit this mode of development; in the second place, it is not easy to draw a hard and fast line between this budding and the breaking up of a *Lumbriculus* into pieces which are severally capable of independent growth.

As to structure, it is difficult to fix upon characters which absolutely divide the two families. *Ilyodrilus* is a Tubificid in, perhaps, most of its characters; the position, for instance, of the generative apertures is as in other Tubificidae; the vascular system has the complications that are found in other members of that family, but are not found in the Naids. The spermiducal glands, however, are Naidiform. *Uncinais* is another annectent form; it certainly shows the cephalization so characteristic of, but not universal in, the Naids; on the other hand, the sexual organs[1] are situated further back than in any other Naid in which their position is known; finally, the setae are entirely uncinate—a state of affairs not found in any other Naid, but often met with among the Tubificidae, e.g. in *Limnodrilus*.

The Lumbriculidae are, at first sight, rather far removed from the Naids and the Tubificids; but, at best, the separation cannot be a wide one; compared, for example, to the characters which separate two such well-marked families as the Geoscolicidae and the Eudrilidae, the differences between the Lumbriculidae and the Tubificidae are by no means great. The main difference is the fact that in the Lumbriculidae there are two pairs of sperm-ducts; this character is quite universal if we except certain dubious forms, to be dealt with immediately. In *Sutroa*, however, which EISEN (2) has justly referred to the Lumbriculidae, one of the two pairs of sperm-ducts is decidedly smaller than the other, and seems to show

[1] It is possible, however, that, as BENHAM has pointed out, the 'testes and ovaries' of *Uncinais* are in reality sperm-sacs and egg-sacs; in this case the position of the generative organs may not be so unlike that of other Naids.

some evidence of commencing disappearance; a second stage in this disappearance is, possibly, exhibited by the genus *Phreodrilus*, a genus of rather doubtful affinities; in this Annelid the single sperm-duct is furnished with a diverticulum which joins it some way before it opens into the terminal gland. This diverticulum is, indeed, not ciliated, and its epithelium is in some other particulars unlike that which line the sperm-ducts; it is more like the epithelium which lines the spermatheca of the same worm, and I have suggested that we may possibly have here an indication of the formation of a spermatheca out of the second sperm-duct, which would be a remarkable and interesting example of a change of function. A third step is seen in *Alluroides*, a genus which, I think, is necessarily to be referred to the Lumbriculidae; in this Annelid the sperm-ducts are a single pair only. Apart from the forms that have been considered, there are no others that appear to show marked intermediate characters between the Tubificidae and the Lumbriculidae; but a consideration of these genera leaves very few points in which the Lumbriculidae are peculiar; the only point is really the presence of a gland near to the spermathecae, which has been called the Albumen gland; this gland has not hitherto had its counterpart in the family of the Tubificidae; but quite recently a gland, which appears to me to be strictly comparable, has been described in *Embolocephalus velutinus*, a worm which, in all its other characters, must be undoubtedly referred to the Tubificidae, though presenting also certain points of affinity to the Naids.

The only other point which, in the present state of our knowledge, seems to distinguish the Lumbriculidae from other worms (including the Tubificidae), is in the vascular caeca. This structural peculiarity is not quite universal; for *Stylodrilus* has not these caecal appendages, and Vejdovsky (**24**) has spoken of it as a genus which, in many respects, recalls the Tubificidae. There are no other points in which the Lumbriculidae as a whole are to be distinguished from the Tubificidae; no Lumbriculid has capillary setae, but then these setae are occasionally wanting in the Tubificidae—for instance, in the genera *Clitellio* and *Limnodrilus*; moreover, the dorsal setae of *Phreodrilus* seem to be intermediate between ordinary capillary setae and the sigmoid setae of the Lumbriculidae.

Family LUMBRICULIDAE

Definition. **Aquatic Oligochaeta of moderate size. Setae paired and ſ-shaped, sometimes with the free extremity bifid. The dorsal blood-vessel or the**

transverse vessels with blind contractile appendages (exc. ***Stylodrilus*** **[1]). Two pairs of sperm-ducts (exc.** ***Alluroides*****) uniting to open by a single spermiducal gland on each side, which lies in front of oviducal pores. No penial setae.**

It contains only eight well-characterized genera, viz. *Lumbriculus*, *Rhynchelmis*, *Trichodrilus*, *Stylodrilus*, *Claparedilla*, *Phreatothrix*, *Eclipidrilus*, *Alluroides*, and *Sutroa*; to these should, perhaps, be added *Pseudolumbriculus*. There are, however, several imperfectly described genera which may very possibly belong to the same family.

VEJDOVSKY (**24**) places here GRUBE'S genera *Bythonomus* and *Lycodrilus*, more doubtfully CZERNIAVSKY'S genus *Archaeodrilus*. They are, however, all ranged by VEJDOVSKY, as well as by VAILLANT (**6**), as 'incertae sedis.' *Bythonomus* possesses blind appendages to the dorsal vessel, which character led VEJDOVSKY to associate it with the Lumbriculidae. The position of CZERNIAVSKY'S genus *Archaeodrilus* is more doubtful. There is nothing in the diagnosis of the genus or in the description of the two species to prove that the genus is a Lumbriculid.

The two distinctive characters of the family, which are not found in any other family or genus, are the contractile appendages of the blood-vessels, and the arrangement of the vasa deferentia.

As to the *contractile blood-sacs*, they have been described by most of those authors who have treated of the anatomy of the Lumbriculidae; by GRUBE (**9**), (who mistook them for diverticula of the intestine), by CLAPARÈDE (**2**), RATZEL (**3**), VEJDOVSKY (**24**), VAILLANT (**6**), DIEFFENBACH and EISEN (**23**, **5**); they are figured by CLAPARÈDE (for *Lumbriculus*), VEJDOVSKY (*Claparedilla*, *Phreatothrix*, *Rhynchelmis*, and *Lumbriculus*), EISEN (*Sutroa*, *Eclipidrilus*), and VAILLANT (*Lumbriculus*). Their arrangement differs in various genera; in all they consist of either simple, or branched, caecal diverticula of the dorsal vessel or of the perivisceral vessels; they are covered, like the dorsal vessel, with chloragogen cells, loaded with dark granules—a fact which, as DIEFFENBACH has pointed out, probably led GRUBE to regard them as diverticula of the intestine. They are contractile, and, as they lie freely in the coelom, their position alters with each movement. I have already treated of the probable homologies of these organs.

The sperm-ducts and the spermiducal glands of the Lumbriculidae differ from those of most other Oligochaeta. There are nearly always (not in *Alluroides*) two pairs of sperm-ducts which open into two consecutive segments, generally the ninth and tenth. The sperm-duct, which communicates with the anterior funnel, opens directly into the ciliated spermiducal gland, the orifice of which is placed upon the tenth segment; the second pair of funnels open into the tenth segment, and are closely attached to its posterior septum; the sperm-duct traverses this septum directly it

[1] And probably *Alluroides*.

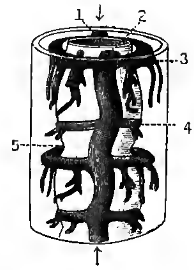
leaves the funnel, and then, bending back again, passes through the septum, to open independently of the anterior vas deferens into the terminal gland.

In *Sutroa* (see Eisen **2**, **5**, Beddard **81**) the plan upon which the male efferent apparatus is constructed is the same, but the spermiducal gland is enormously long.

Eclipidrilus is altogether anomalous.

Vejdovsky divides the family into two sub-families, (1) Trichodrilina and (2) Lumbriculina, characterized by the absence (in the former) or the presence (in the latter) of a paired or unpaired albumen-gland. *Sutroa* would, perhaps, be included in the second sub-family; but it differs quite as much from either sub-family as the two sub-families do from each other; *Eclipidrilus* and *Alluroides* would, undoubtedly, need a fourth and fifth sub-family for their reception, if, indeed, it is justifiable to include them in the family Lumbriculidae at all. As it is, in my opinion, undesirable to break up so small a family (containing only twenty species) into four sub-families, I would prefer to separate it only into genera.

Fig. 37.



LUMBRICULUS : BLOOD-GLANDS.

(after Claparède.)

1. Ventral blood-vessel. 2. Dorsal blood-vessel. 3–5. Branches of last with caecal twigs.

The following table (p. 210) shows the resemblances and differences between those genera, excepting *Eclipidrilus*, whose structure is known.

Another aberrant Lumbriculid is *Alluroides;* this genus, which is a native of tropical East Africa, was described by myself quite recently (**84**); it has the outward form of a Tubificid, but agrees with the Lumbriculidae in the following points:—

(1) The setae are all S-shaped; they are paired.

(2) The spermiducal gland is clothed by a thick glandular layer.

(3) The longitudinal muscle-layer of the body-wall is formed by a single row of deep plates.

These three characters do not co-exist in any worm that does not belong to this family. In other points that are not distinctive of the Lumbriculidae, but which are characteristic of all the genera of that family, *Alluroides* agrees with other Lumbriculidae. These are:—

(1) Ova of large size, and filled with yolk.

(2) No glands appended to the alimentary tract except septal glands.

(3) No gizzard.

(4) Funnels of the sperm-duct a segment in advance of the spermiducal gland.

(5) Ovaries in segment containing spermiducal gland.

And in a number of other small points, without which the genus could not be

assigned to the neighbourhood of the Lumbriculidae, but which are not of themselves sufficient to show its affinities to that family more than to other families of the aquatic Oligochaeta.

The principal differences from the Lumbriculidae are the following:—

(1) No vascular contractile caeca (these, however, are absent in *Stylodrilus*).

(2) A single pair only of testes and sperm-ducts.

(3) The position of the male-pores upon the thirteenth segment, and the related fact that the sperm-ducts pass through several segments on their way to these pores.

(4) The position of the ovaries in the thirteenth segment, and of the oviducal pores upon the following segment.

These characters do not unite this genus with the Tubificidae or with any other aquatic Oligochaeta; they point, on the whole, to the terrestrial genera, and particularly, perhaps, to *Allurus;* hence the name *Alluroides*, which I have given to the genus. I have already discussed these characters in the section dealing with the general classification of the Oligochaeta.

	SETAE.	SPERMATHECAE.	SPERMIDUCAL GLANDS.	SPERM-DUCTS.	ALBUMEN GLANDS.	OTHER PECULIARITIES.
Lumbriculus .	bifid	in x, xi, xii	in viii	?	in ix	
Claparedilla .	simple	in ix	pear-shaped, opening on x	two pairs	o	
Trichodrilus .	simple	in xi, xii	pear-shaped, opening on x	two pairs	o	
Stylodrilus .	bifid	in ix	pear-shaped, opening on x	two pairs	o	clitellum x–xii; a pair of rigid penes
Rhynchelmis .	simple	in viii, with single diverticulum	long, opening on x	two pairs	medium in ix	clitellum viii–xvi
Phreatothrix .	simple	in xi (and xii)	opening on x	two pairs	o	
Sutroa . .	simple	single in viii, with many diverticula	long, opening on x	two pairs, anterior thinner	o	coelomic sacs on walls of x, xi; clitellum vii–xv
Alluroides .	simple	in viii	long, opening on xiii	one pair	o	clitellum xiii–xvi; a pair of rigid penes

The affinities of this family in one direction are not plain; the two pairs of sperm-ducts, with the corresponding two pairs of testes, do not occur in any other group among the aquatic Oligochaeta; there is, so far, a resemblance to the terrestrial

genera, which is, however, not borne out in other particulars. It is true that among earth-worms it does not seem possible to lay much stress upon the existence of one or of two pairs of sperm-ducts; but the existence of two pairs is so rare an occurrence among these aquatic forms that it seems to have more importance; hence it appears to me to be quite justifiable to found a family character upon it.

Although it is difficult to institute any affinities between the Lumbriculidae and the higher Oligochaeta, their relationships to the lower forms are, perhaps, rather more obvious; as VEJDOVSKY (**24**) has said, the genus *Stylodrilus* is in certain particulars not far removed from the Tubificidae; this genus has not the branched caecal appendages of the dorsal blood-vessel. A better intermediate genus or, rather, family, for I have placed it in a distinct family here, is *Eclipidrilus;* that genus has the caecal appendages of the Lumbriculidae, but it has also spermatophores which are quite unknown in the Lumbriculidae; I have also called attention to the structure of the spermiducal gland, so far as we know it, as affording evidence of a resemblance to the Tubificidae; the position, also, of the oviducts in the genus *Eclipidrilus* is more like what is found in the Tubificidae than the position which characterizes the Lumbriculidae.

The Lumbriculidae, however, also show affinities to the Naidomorpha; this is chiefly seen in the nephridia; in both these families (and also in *Ilyodrilus*—a low form of the Tubificidae) there is a conspicuous brown mass immediately following the funnel of the nephridium; nothing of the same kind occurs in any other group of Oligochaeta.

LUMBRICULUS, GRUBE.

Lumbriculus, GRUBE. *non* CLAPARÈDE.
Lumbricus, O. F. MÜLLER (in part.).
Saenuris, JOHNSTON.
? **Acestus**, LEIDY.

DEFINITION. **Greatly elongated worms, aquatic in habit. Setae bifid at extremity. In each segment, after eighth, a pair of blind branched diverticula of dorsal vessel, and a pair of non-contractile perivisceral trunks uniting dorsal and ventral vessels. Spermiducal glands in VIII. Spermathecae in X, XI, XII. Oviducts in X, XI. Albumen-glands in IX.**

DIEFFENBACH has lately given strong reasons for believing that GRUBE and CLAPARÈDE did not base their descriptions of *Lumbriculus variegatus* upon the same species, or even upon the same genus. CLAPARÈDE himself remarked (**2**) upon the differences between the facts observed by himself, with reference to the structure of this worm, and the description given by GRUBE, but

considered that these discrepancies were due to errors on the part of GRUBE. DIEFFENBACH'S paper was published about the same time as VEJDOVSKY'S great work upon the Oligochaeta (**24**), and is, accordingly, not referred to there. VEJDOVSKY, however, has not passed over the divergent accounts given by GRUBE and CLAPARÈDE, and has pointed out that CLAPARÈDE'S '*Lumbriculus*' is really identical with *Claparedilla;* as this name, instituted by VEJDOVSKY in 1883, has the priority over DIEFFENBACH'S name *Pseudolumbriculus*, it must clearly be retained.

Our knowledge of the structure of this genus is principally due to VEJDOVSKY (**24**), RATZEL (**3**), and to DIEFFENBACH, and is restricted to that of the species *Lumbriculus variegatus.* This knowledge is, unfortunately, far from being complete, as the sexual organs have been, as yet, only imperfectly described.

The *setae* are disposed in pairs, and are bifid at their free extremity.

There is, as LEYDIG first discovered, a pore upon the dorsal side of the prostomium, which is not always evident; it puts the cavity of the prostomium into communication with the exterior. DIEFFENBACH states that in the neighbourhood of the pore there are cilia present; and BÜLOW (**1**) describes nerves which arise from the cerebral ganglia and supply this region, which he regards as an organ of taste.

The nervous system of *Lumbriculus* is formed upon the same plan as that of other Oligochaeta; the cerebral ganglia are figured by VEJDOVSKY (**24**, Taf. xii, p. 28), the cerebral ganglia and the commencement of the ventral cord by RATZEL (**3**, fig. 10, Taf. xlii.), and LEYDIG (**7**, Taf. iv. fig. 6). The brain (cerebral ganglia) consists of two ganglia, which are composed of nerve-cells anteriorly and fibres posteriorly; the two masses of cells are united by a narrow row of cells. The commissures passing round the oesophagus have no ganglionic cells; where they join the ventral chain there is a group of cells in front of, and behind, the point of junction. The neuro-chord forks at the commissure, and extends along the commissure for a very short way on each side. VEJDOVSKY represents the brain as more extensively cellular than does RATZEL, whose account has been followed above. According to VEJDOVKSY, the ventral nerve-chord gives off only a single pair of nerves in each segment, which almost immediately perforate the muscles of the parietes. Transverse sections show the presence of these 'giant fibres.' A pair of lateral ganglionated nerves are present.

The sense-organs of *Lumbriculus* consist, according to RATZEL, of 'a sharply-marked white stripe in the median ventral line,' which gradually fades away posteriorly. This streak is composed of irregular spots, which consist of groups of cells in intimate connexion with the nerve-chord. VEJDOVSKY has denied the existence of this sense-organ; he describes, however, the cup-shaped tactile organs of which mention has already been made.

The alimentary canal is, with the exception of the buccal cavity, ciliated throughout. It commences with a strong muscular pharynx, which can be everted

and retracted by means of special muscles attached to the body-wall; it occupies segments ii–iv, the space in front belonging to the buccal cavity. The oesophagus occupies the next two segments, the intestine commencing in the seventh. The commencement of the intestine is marked by the chloragogen-cells which cover it throughout; it is lined by columnar ciliated cells which are narrow at their base; between them lie roundish cells, which appear to be young cells in course of growth; outside the lining epithelium is a delicate muscle-layer, consisting only (DIEFFENBACH) of circularly-arranged fibres. An abundant plexus of excessively fine blood-vessels surrounds the gut.

The vascular system consists of a dorsal and ventral blood-vessel, which are united by transverse trunks, and of a series of caecal appendages of the dorsal vessel. The dorsal vessel lies close to the dorsal wall of the gut, being covered by the chloragogen-cells; in the first segment it divides into two the branches reuniting on the ventral side of the gut in the sixth segment. The dorsal and ventral vessel are united by pairs of non-contractile transverse vessels in every segment; in the first eight segments (DIEFFENBACH), or fifteen (RATZEL), these transversely running trunks give rise to branches which form a complicated and irregular network, continuous from segment to segment. At the ninth segment the network entirely ceases, and the simple vessels, which are at first much coiled, alone remain; they lie in the posterior region of each segment. In front of each, commencing with the ninth segment, are a pair of lateral vessels, also arising from the dorsal trunk, which branch and end blindly; at first the branches are less numerous; afterwards each vessel has from eight to ten; they are attached to the parietes by slender contractile fibres; they are themselves contractile.

VEJDOVSKY'S account differs somewhat from that of DIEFFENBACH—so much so that one is inclined to believe that the two naturalists studied different species.

According to VEJDOVSKY, who examined young specimens (and starving, so that the vessels were specially clear, owing to the empty condition of the alimentary canal), each segment from the ninth to the sixteenth, has only a pair of non-branched, but *contractile*, vessels situated close to the posterior dissepiment; from the seventeenth segment onwards there is no trace of these vessels. In the thirteenth segment the branched vessels commence, but in the thirteenth segment they are only short caecal appendages of the dorsal vessel; the branching becomes quite obvious at about the seventeenth segment.

The nephridia commence in the ninth segment; they are present, at least, in some of the genital segments, when the worm is matured. Where the funnel passes

into the canal a granular, glandular-looking mass is present (cf. with Naids and *Ilyodrilus*).

The regeneration of the tail has been studied principally by v. Bülow (**1, 2**) and Randolph (**4**). The principal point of interest in the actual process of regeneration concerns the formation of the mesoblast. This appears to be produced by the division of large peritoneal cells, which can be distinguished in the body-cavity of the adult worm; the name 'neoblasts' is suggested by Randolph for these cells. This process of growth justifies a comparison between the regenerative process in this Annelid and the 'budding' of Naids (see below). In the latter worms the budding zone begins to be formed by a multiplication of peritoneal cells. The suggestion has been made that these neoblasts correspond to ova which are also, of course, peritoneal cells.

Vaillant (**6**) allows five species to this genus, viz.:—

(1) *Lumbriculus variegatus*, Grube.
(2) *Lumbriculus limosus*, Leidy.
(3) *Lumbriculus spiralis*, Leidy.
(4) *Lumbriculus hyalinus*, Leidy.
(5) *Lumbriculus lacustris*, Czerniavsky.

The last, however, with a query, and justly; for in the description given there is not a particle of evidence that it is not, for example, a *Clitellio*. With regard to the two species, *Lumbriculus spiralis* and *L. hyalinus* (first of all placed by Leidy in a separate genus, *Acestus*), there is, again, not the slightest evidence that they belong to this genus. The fact that there are from three to five or from three to eight setae in each bundle argues rather that they are referable to some Tubificid like *Limnodrilus*; and that is the only possible character that can be drawn from the definition.

Lumbriculus limosus, on the other hand, appears at least a Lumbriculid, and it may be a *Lumbriculus*; but the pores on the tenth segment suggest male pores, in which case it is not a *Lumbriculus*. There are fifteen pairs of vascular caeca in each segment.

Lumbriculus variegatus, O. F. Müller.

Lumbriculus variegatus, O. F. Müller, Verm. terrestr. vol. i. 2, 1774, p. 26.
Lumbriculus teres, Dalyell, Powers of the Creator, vol. ii. 1853, p. 140.
Saenuris variegatus, Johnston, Cat. Worms, 1865, p. 65.

Definition. *Length* 80 *mm.; number of segments,* 200*; body dark green anteriorly;* 6–8 *caecal appendages of dorsal vessel in each segment posteriorly. Hab.—Europe.*

This, the earliest known species of Lumbriculid, is much more imperfectly known than most others; the reproductive organs have not yet been properly described. The species has been studied by d'Udekem (**1, 5**), Buchholtz, Ratzel (**3**), Vejdovsky (**24**), Bülow (**1, 2**) and Randolph (**4**), in addition to the authorities quoted above. Figures are given by Bonnet (Pl. i. figs. 1–5), Grube (**9**, Pl. vii.

figs. 2 *a–d*), DALZELL (Pl. xviii, figs. 10–12), BUCHHOLTZ (fig. 16), RATZEL (**3**, Pl. xlii. figs. 6, 10, 11, 14, 19), VEJDOVSKY (**24**, Pl. viii. fig. 68, pl. xii. figs. 16–32), BÜLOW (**1**, **2**), RANDOLPH (**4**).

Genus RHYNCHELMIS, HOFFMEISTER.

Syn. **Euaxes**, GRUBE.

? **Lycodrilus**, GRUBE.

DEFINITION. **Setae not bifid at tip; clitellum VIII–XVI; prostomium elongate; testes in IX, X; ovaries in XI; sperm-sacs and egg-sacs paired, extending through a large number of segments; spermiducal glands opening on to X, with a coating of glandular cells broken up into rounded masses; spermathecae one pair opening on to VIII, each pouch with a single diverticulum; a single median albumen-gland opens on to IX.**

The name *Rhynchelmis* is obviously the right one to apply to this genus; but the synonym *Euaxes* has persisted for a long time, in spite of the fact that GRUBE himself recognized the identity of his *Euaxes filirostris* with HOFFMEISTER'S (**3**) *Rhynchelmis*. D'UDEKEM (**1**), for example, has retained the name *Euaxes*, although he gave correctly the synonymy of the species *filirostris;* so, too, CLAPARÈDE (**2**) and VAILLANT (**3**). In his later work (**6**) VAILLANT has set this matter right, pointing out that GRUBE 'in 1851 preserved his own generic name of 1844, though giving as a synonym *Rhynchelmis* with the date 1843.' VAILLANT (**6**) considers that GRUBE'S genus *Lycodrilus* must also be regarded as a synonym of *Rhynchelmis;* this genus was created for a species, *L. dybowskii*, from Lake Baikal; from GRUBE'S account it would appear to differ from *Rhynchelmis* by the presence of large bifid setae, replacing the setae on the ventral side of the body on segments ii–x. I am disposed, therefore, to agree with VEJDOVSKY (**24**) in not referring the worm to the present genus, but to regard it as 'incertae sedis.' Though using the name *Lycodrilus* as a synonym of *Rhynchelmis*, VAILLANT prefaces the description of the species *L. dybowskii* by a query. Our knowledge of the anatomy of this genus dates from the publication of VEJDOVSKY'S important paper upon this worm (**5**). Neither HOFFMEISTER nor GRUBE gave any satisfactory details upon the internal structure; their memoirs were devoted almost exclusively to the external characters; when GRUBE did venture upon any references to structure, they were by no means successful; for example, he mistook the contractile appendages of the dorsal blood-vessel for caeca of the gut, which are non-existent. Some few additional details and figures were given by the same author in his work upon the Oligochaeta (**8**). The reproductive organs and the development have been recently described by VEJDOVSKY (**24**), some of his earlier statements being revised; the only other author who has written upon this genus is KOVALEVSKY, who investigated its development a good many years before the appearance of VEJDOVSKY'S work upon the same subject.

The genus *Rhynchelmis* is, so far as our present knowledge goes, confined to the fresh waters of Europe; it has been met with in Bohemia, Russia, Belgium, and Germany; I point out later that certain species, referred to this genus from other parts of the world, are probably not really referable to it. I have seen a specimen

from some part of England[1], but cannot give any details. There is every probability that it is a native of this country.

The most salient external character of the genus is the long *prostomium;* the peculiar form of this is sufficient to prove that HOFFMEISTER and GRUBE were dealing with the same worm in their descriptions of *Rhynchelmis* and *Euaxes;* the same kind of prostomium occurs also in the nearly-related genus *Sutroa* from North America; but nothing of the kind is found in any other Lumbriculid; in *Nais proboscidea,* however, there is a prostomium which is of the same character.

The *nephridia* are, of course, paired structures; they commence in immature individuals in the seventh, in mature individuals in the twelfth, segment. The nephridia become enormously large in proportion to the worm; they stretch so far back beyond their point of opening that, 'on a superficial inspection each nephridium has the appearance of occupying several segments.' The nephridiopores are placed in front of the ventral setae.

The *vascular system* of *Rhynchelmis* is described in some detail in VEJDOVSKY'S original paper upon the anatomy of the worm; a good figure of some additional particulars is to be found in the Entwickelungsgeschichtliche Untersuchungen (Pl. xxviii. figs. 7 and 8). The dorsal vessel is pulsatile; it communicates with the ventral vessel by a series of perivisceral trunks, a pair to each segment; after the eighth segment there are, in addition, a pair of vessels arising from the dorsal trunk, which do not end in the ventral vessel, but give off a number of contractile branches, as in other Lumbriculidae; there are six or eight pairs of these branches, which were confused by GRUBE with diverticula of the gut; when the worms have attained to sexual maturity, the ninth, tenth, and eleventh segments, are seen to contain each a pair of long vessels, giving off a rich network, which ramifies over the sperm-sacs and the other reproductive organs; the intestine has a rich plexus, derived from the paired, non-contractile perivisceral trunks. The ventral vessel consists, in the first five segments of the body, of two separate halves, each half receiving the perivisceral trunk of its own side.

The *testes,* at first overlooked by VEJDOVSKY, were subsequently (**9**) recognized by him as two pairs of gonads in the ninth and tenth segments; as the worm gets to be mature, the testes disappear, their contents being transferred to the sperm-sacs; the same thing happens to the ovaries, which lie in the eleventh segment. The sperm-sacs have been already described in sufficient detail (p. 93). The spermathecae and the sperm-ducts open behind the ventral pair of setae of their segment; the albumen gland opens in the middle line, between these setae; the oviducal pores are

[1] I believe this specimen to be in the Oxford Museum.

on the border-line between segments xi/xii, behind the ventral setae. The structure of the reproductive organs has already been described in treating of the characters of the family.

(1) Rhynchelmis limosella, Hoffmeister.

R. limosella, Hoffmeister, Arch. f. Nat. 1843, p. 192.

Euaxes filirostris, Grube, Arch. f. Nat. 1844, p. 204.

Definition. *Length*, 120 *mm.; number of segments*, 150. *Body more or less quadrangular. Prostomium long. Setae posteriorly reduced to one in each bundle; chloragogen-covering of gut commences in the seventh segment. Hab.—Europe.*

Illustrations of this species and of its development are given in the following papers and books: Grube (**9**, Pl. vii. figs. 1 *a–d*), Menge (Pl. iii. pp. 14–17), Kovalevsky (Pls. iii–v), Vejdovsky (**5**, Pls. xxi–xxiv), **24**, Pl. xii. figs. 33, 34, Pl. xiii. figs. 1–11, Pl. xv. fig. 27, Pl. xvi. figs. 1–16).

(2) Rhynchelmis obtusirostris, Menge.

Euaxes obtusirostris, Menge, Arch. f. Nat. 1845, p. 31.

Definition. *Length*, 55 *mm.; number of segments*, 100. *Prostomium obtuse. Hab.—Belgium; Germany.*

The principal reason for retaining this species (figured by Menge [Pl. iii. figs. 1–13]) is that d'Udekem and Menge had the opportunity of studying both this species and the last, and were, therefore, presumably not likely to have made an error. Otherwise, as Vaillant says (**6**, p. 220), the characters are very incomplete.

Genus TRICHODRILUS, Claparède.

Definition. Setae simple; dorsal vessel with 2–5 contractile perigastric branches, but with no caeca; spermathecae in XI, XII; male pores on X.

This genus has been investigated by Claparède only. It comes very near to *Phreatothrix*, from which it differs principally in the fact that it has no *caecal* appendages of the dorsal blood-vessel. There is but one species—

Trichodrilus allobrogum, Claparède.

T. allobrogum, Claparède, Mém. Soc. Phys. Gen. 1862, p. 267.

Definition. *Length*, 25 *mm.; about* 70 *segments. Prostomium conical, long, not separated by furrow from buccal segment. Spermathecae opening behind ventral setae. Nephridia in VI and then again from XII onwards. Hab.—River Seine (Geneva).*

The anatomical characters are fully illustrated in Claparède's memoir.

Genus PHREATOTHRIX, VEJDOVSKY.

Syn. **Trichodrilus**, VEJDOVSKY.

DEFINITION. **Setae sigmoid, not uncinate; one pair of spermathecae in XI. In posterior region of body, five or six pairs of lateral contractile branches of dorsal vessel in each segment.**

This genus, first described by VEJDOVSKY as a species of *Trichodrilus*, was subsequently (**24**) recognized as a distinct genus. Our knowledge of its structure is entirely due to VEJDOVSKY.

The reproductive organs are like those of *Trichodrilus*, except for the fact that there is only a single pair of spermathecae lying in the eleventh segment; in the twelfth segment, however, a rudimentary second pair make their appearance, but only acquire traces of a lumen, and finally completely degenerate. The external orifices of the spermathecae lie behind the ventral setae[1]. There is no albumen-gland.

The nephridia are very remarkable; the first pair appears to belong to the eighth segment; the funnels open into the coelom of the seventh segment, and the external pore of the organ is upon the eighth segment; but the tube which connects these two openings extends back through the body as far as the fourteenth segment. The second pair of nephridia is similarly elongated. The funnels open into the thirteenth segment, and the external pores are upon the fourteenth segment. The tube is looped back as far as the twenty-first segment. Behind this, each pair of nephridia extends through three segments, although, as before, the internal and external apertures are upon successive segments.

The principal point of interest in the circulatory system is the condition of the characteristic appendages of the dorsal vessel. There are in the posterior segments of the body five or six pairs of these to each segment, which are not regular in their arrangement; each of these branches terminates in a bifid extremity. The blood is described by VEJDOVSKY as being yellow rather than red. There are eight pairs of perivisceral vessels uniting the dorsal and ventral trunks in the anterior segments. The ventral vessel is forked in the fourth segment. In the young worm septal glands can be made out in the anterior segments. There are four pairs of these lying in segments iv–viii; the glands of each side of the body are connected by a longitudinal strand, which is the duct, and which opens into the pharynx. They are not so plain in older worms.

[1] In VEJDOVSKY's first account of the anatomy of this species (21) the setae of this segment are stated to be absent.

The brain lies in the first and second segments; it has marked anterior and posterior paired lobes. Behind the pharynx a circle of nervous cells surrounds the oesophagus, as in *Chaetogaster*.

Phreatothrix pragensis is the only species well known. It may be that *Euaxes baicalensis* of GRUBE (**4**) is referable to the same genus, perhaps even to the same species. It possesses a pair of papillae on the tenth segment (clearly the male pores), and a pair of orifices on the eleventh segment, which I agree with VAILLANT (**6**, p. 221) in considering to be spermathecal orifices.

Phreatothrix pragensis, VEJDOVSKY.

Trichodrilus pragensis, VEJDOVSKY, SB. Böhm. Ges. 1875, p. 196.

Phreatothrix pragensis, VEJDOVSKY, Z. Wiss. Zool. 1876, p. 541.

Definition. *Length*, 40 *mm.; number of segments*, 80. *Prostomium twice as long as buccal segment, obtuse; five anterior segments bi-annulate. Hab.—Prague, in wells.*

To give any other characters in definition of this species would be merely, in the present state of our knowledge, to redefine the genus.

Genus **CLAPAREDILLA**, VEJDOVSKY.

Syn. **Lumbriculus**, CLAPARÈDE.

Pseudolumbriculus, DIEFFENBACH.

DEFINITION. Setae not bifid; both pairs of contractile perivisceral vessels with caecal appendages; spermathecae in IX.

I have already gone into the question of the probable identity of VEJDOVSKY'S genus *Claparedilla* with CLAPARÈDE'S *Lumbriculus* (see p. 211). The genus has been exclusively studied by the two writers whose names have just been mentioned.

CLAPARÈDE stated that the setae are 'simple, or indistinctly bifid'; but VEJDOVSKY found in the species studied by himself, and also in CLAPARÈDE'S species, that the setae did not show any bifurcation; this slight point of difference, for, after all, CLAPARÈDE is not very decisive upon the matter, should not, perhaps, be made too much of. The vascular system is very characteristic of the genus, but appears to differ a little in the two species; the details will, therefore, be reserved until the species are described; but, in the meantime, it may be pointed out as characteristic of the whole genus that both pairs of branches of the dorsal vessel are provided

with caecal diverticula. The nephridia commence in the seventh segment, but are wanting in the following segments; they recommence again in the thirteenth. The only two known species of the genus are European.

(1) Claparedilla meridionalis, Vejdovsky.

C. meridionalis, Vejdovsky, SB. Böhm. Ges. 1883, p. 226 (footnote).
Lumbriculus variegatus, Claparède, Mém. Soc. Phys. Gen. 1862, p. 255.
Non-**Lumbriculus variegatus**, Grube et Auct.
Pseudolumbriculus Claparedianus, Dieffenbach, Anat. u. Syst. Studien, p. 81.

Definition. *Prostomium as long as buccal segment; anterior perivisceral vessels in each segment covered with chloragogen-cells, dilated where they join ventral vessel, and giving off there four or five caeca; posterior perivisceral vessels with pennate series of branches.*
Hab.—Geneva; Trieste.

I follow Vejdovsky in identifying his *Claparedilla* with Claparède's *Lumbriculus variegatus;* there are, however, certain differences in the descriptions given by these two writers, which are not easy to reconcile with the theory that they were describing the same species. The question of the bifurcation or the non-bifurcation of the setae has been already referred to. Of more importance, perhaps, is the different account given of the vascular system; according to Claparède the two arches on either side are furnished with contractile caeca which arise only on the posterior margin, in an identical position in the case of each; on the other hand, Vejdovsky has figured and described the posterior of the two arches alone as furnished with a series (double, not single) of caeca arising along its whole length; the anterior visceral arch swells into an ampulla on the ventral side of the body, just at its junction with the ventral vessel; from this swelling are given off three or four caecal appendages; this arch alone is covered with a coating of chloragogen-cells. Claparède describes the same condition as existing in this arch. The dorsal vessel is covered with a coating of the same brown cells from the fourth segment onwards, and the pigmented cells upon the alimentary tract commence in the sixth segment at its end (Claparède). Vejdovsky states that the dorsal vessel is covered with the pigmented cells along its entire length. Dieffenbach's paper dealing with the non-identity of the species termed by both Claparède and Grube *Lumbriculus variegatus*, was published at about the same time as Vejdovsky's great work. His description of the reproductive organs of *Pseudolumbriculus* agree with those of *Claparedilla* (see under *Lumbriculus*).

(2) Claparedilla lankesteri, VEJDOVSKY.

C. lankesteri, VEJDOVSKY, Syst. u. Morph., 1884, p. 54.

Lumbriculus lankesteri, VEJDOVSKY, SB. Böhm. Ges. 1883, p. 226.

Definition. *Prostomium double as long as the buccal segment; first five segments bi-annulate; both pairs of perivisceral arches with pennate series of caeca. Hab.—Podebrad, Bohemia.*

As this species is only known by a single immature example, it cannot be regarded as absolutely certain that it should be included in the same genus as the last; the difference in the arrangement of the contractile caeca of the perivisceral vessels is made use of in the definition of the species. It will be noticed that the arrangement which characterizes the present species is more like that of the last species as described by VEJDOVSKY.

Genus STYLODRILUS, CLAPARÈDE.

DEFINITION. **Setae bifid; clitellum, X–XII; spermathecae, a pair in IX; a pair of non-retractile penes present on segment X, perforated by sperm-ducts; spermiducal gland pear-shaped, with long duct.**

This genus has been anatomically described by CLAPARÈDE (**2**) and by VEJDOVSKY (**24**); more recently, BENHAM (**9**) has described a new species of which he has detailed the structure. A few details upon *Stylodrilus* have also been contributed by RATZEL (**3**).

The *vascular system* consists of the usual dorsal and ventral vessels put into communication in each segment by two pairs of vessels, both of which, as well as, of course, the dorsal vessel, are contractile; one of the communicating vessels is called by CLAPARÈDE the 'anse intestinale.' the other 'anse périviscérale.' The former lies anteriorly in the segment, instead of posteriorly, as in *Claparedilla;* it is imbedded in the peritoneal cells which cover the intestine, but is nevertheless easy to see on account of its large size; neither of the trunks shows any caecal appendages, such as exist in other Lumbriculidae.

The *nephridia* are wanting in the first six segments. They exist in the seventh and from the thirteenth onwards. The external pore is in front of the ventral setae.

The most remarkable feature about the reproductive organs is the existence of a pair of penes which are non-retractile, but are perforated by the sperm-duct; they exist in all three species of the genus, and lie behind the ventral setae; the

spermathecae open in a similar position behind the ventral setae of the ninth segment.

The three species of the genus are the following:—

(1) Stylodrilus heringianus, Claparède.

S. heringianus, Claparède, Mém. Soc. Phys. Gen. 1862, p. 263.

Definition. *Length*, 30 *mm.; number of segments*, 80. *Prostomium obtuse. Dorsal vessel without dilatation. Penis as long as half diameter of body. Hab.—Geneva; Bohemia.*

Claparède has figured all the important organs of the body in this species. A curious point is the existence of a large octaedral crystal in the spermathecae, which seems to distinguish this species from the next. Vejdovsky found this species in Bohemia.

(2) Stylodrilus gabretae, Vejdovsky.

S. gabretae, Vejdovsky, SB. Böhm. Ges. 1883, p. 225.

Definition. *Length*, 40 *mm. Prostomium conical. Dorsal vessel with dilatations; hearts in VI and VII; penis nearly equal in length to the diameter of the body. Hab.—Bohemia.*

This species is fully illustrated by Vejdovsky in his work upon the Oligochaeta.

(3) Stylodrilus vejdovskii, Benham.

S. vejdovskii, Benham, Quart. J. Micr. Sci. xxxiii. p. 209.

Definition. *Length*, 25 *mm.; dorsal vessel not dilated; nephridia of first two pairs extend through three or four segments. Penis just greater than half diameter of body. Hab.—River Cherwell, England.*

This species (illustrated by Benham) is said to differ from the other two in that the setae are *all* notched. But, as these kinds of setae appear to be liable to wear, the difference is, perhaps, not real. The nephridia are obviously like those of *Phreatothrix* (see p. 218).

Genus Sutroa, Eisen.

Definition. **Prostomium elongated; setae not bifid; clitellum VII/XV; spermiducal glands enormously elongate, and furnished with a coating of glandular cells, broken up into globular masses opening on to X; the sperm-sacs surround the spermiducal glands; a single spermatheca in VIII, with numerous branched and simple diverticula. Testes in X; ovaries in XI; oviducal pores on XI/XII.**

This genus, which is in many respects a very remarkable one, is confined, so far as our present knowledge goes, to California. Its anatomy has been described by EISEN (**2**, **5**) and by myself (**81**). The genus contains two species.

Sutroa agrees with *Rhynchelmis* in its long and filiform prostomium; in many other points it differs from that genus. In the first place the spermatheca is single and median, and is furnished with numerous diverticula, which are both branched and single. The very peculiar shape of the spermatheca in *Rhynchelmis*—peculiar, that is to say, as compared with other Lumbriculidae—suggests that one diverticulum is present in the spermatheca of that genus; but in any case the multitudinous caeca of *Sutroa* differentiate it from *Rhynchelmis*, even without going into any other differences.

There are, however, many other points of divergence between the two genera; it is not certain whether there is in *Rhynchelmis* any communication between the spermatheca and the lumen of the gut; VEJDOVSKY (**5**) speaks of 'einen Schlitz, welcher den Eindruck einer Öffnung macht, und in der That bemerkt man, dass unter dem Druck des Deckgläschens auf das Organ nur auf dieser Stelle die Spermatozoenbündel herausgehen.' EISEN (**5**), too, mentioned a pore at the extremity of the spermatheca of *S. alpestris*. 'The object of such an opening,' he remarks, 'is not at present understood.' I have, however, myself shown (**81**) that this aperture communicates with the gut, though this discovery by no means explains the 'object' of the pore; it is, however, not unknown in other Oligochaeta (see p. 127).

A comparison of VEJDOVSKY'S (**5**) original paper upon *Rhynchelmis* with EISEN'S (**2**, **5**) and my own contributions to the anatomy of *Sutroa* would indicate rather greater differences than those that actually exist. VEJDOVSKY'S most recent contribution to the structure of *Rhynchelmis* is contained in his researches upon the development of that Annelid (**9**). From this it appears that the differences are not, after all, so great; the spermiducal glands are, or rather may be, much greater in extent than is suggested in the earlier paper; VEJDOVSKY writes that they may extend as far back as to the thirtieth segment, and that they occupy the cavity of the sperm-sacs; this is exactly what occurs in *Sutroa*, though the glands are by no means so extensive; they reach back as far as the twentieth segment about, and are invested for the whole of their course by the sperm-sacs. A curious point about the sperm-ducts of *Sutroa alpestris* is that the anterior pair are much slighter than the posterior pair; the funnel, too, is less developed; one is inclined to come to the conclusion that the anterior pair of ducts is in course of disappearance, especially since there are no testes corresponding to them. So far, therefore, *Sutroa* seems to connect the Lumbriculidae with the Tubificidae, where there are, of course, only a single pair of testes and funnels; but

I have already gone into this matter in describing the characters of the family Lumbriculidae, and need not recur to it here.

Attached to the anterior septum of the tenth and eleventh segments, and in the latter case close to the testes, are two pairs of bodies, called 'albumen-glands' by EISEN. Their walls are delicate and muscular, and their cavity is subdivided by anastomosing trabeculae derived from the walls; the interspaces thus formed contain loosely-packed cells, which suggest coelomic cells. I could find no duct leading to the exterior, and the fact that the sac on one side of the body contained one of the diverticula of the spermatheca suggests its coelomic character. I should be disposed to compare these sacs broadly to the sperm-sacs, septal sacs, &c.

Sutroa rostrata, EISEN.

S. rostrata, G. EISEN, Mem. Calif. Acad. Sci. (1888), vol. ii. No. 1.

Definition. *Length 75 mm.; ventral vessel forks in segment VIII; only connected with dorsal vessel in prostomium. Cocoon not pointed at ends. Hab.—San Francisco, in lake 50 ft. above level of sea.*

Sutroa alpestris, EISEN.

S. alpestris, G. EISEN, Zoe (1892), vol. ii. p. 323.

Definition. *Length about 40 mm.; ventral vessel forked in segment VI, connected with dorsal vessel by perigastrics in each segment. Cocoon globular and pointed at ends. Hab.—California, Donner Lake, 6,000 ft.*

Genus ALLUROIDES, BEDDARD.

DEFINITION. **Setae simple; male pores on XIII; oviducal pores, XIII/XIV; penes on XIII in front of male pores; testes in X; spermathecae in VIII; no albumen gland; no vascular caeca.**

This genus is at present known by one species only, which has been studied by myself (**84**). The chief points in its anatomy, besides those mentioned in the above description, are the following:—The clitellum is developed upon segments xiii–xvi. There are no special sperm-sacs, the two segments x, xi being filled with developing spermatozoa; the ova lie in a considerable number of segments following that (the thirteenth) which contains the ovaries. The spermathecae are without diverticula of any kind, and have very thick muscular walls, consisting of both circular and longitudinal fibres. The spermiducal glands are long, and have

a thick investment of glandular cells, which are aggregated into groups; their ducts appear to traverse the muscular wall of the spermiducal gland; the gland is ciliated at the end nearest to the external pore; just above the aperture of the gland, on each side of the body, is a process of the body-wall, which is, perhaps, comparable to the penis of the genus *Stylodrilus;* but it is not traversed by the canal of the male duct. The septal glands occupy the fifth to the ninth segment. The nephridia commence in the sixteenth segment; they open in front of the second seta.

Alluroides pordagei, BEDDARD.

A. pordagei, BEDDARD, Q. J. M. S. vol. xxxvi. p. 244.

Definition. *Length about an inch; two pairs of strong hearts in XII, XIII; thick septa IV/XII, that dividing X/XI being thinner. Hab.—Mombasa, East Africa; fresh water.*

The only two specimens known were collected by MR. F. FINN in a swamp about four miles up country, opposite to Mombasa Island; the worm has a delicate appearance, and appears to have no pigment in the skin.

Appendix to Lumbriculidae.

FAMILY ECLIPIDRILIDAE.

DEFINITION. **Aquatic Oligochaeta of moderate size; setae paired, not bifid at extremity, of the usual Lumbricid pattern; the dorsal blood-vessel, with a series of slightly bifid contractile appendages in posterior segments; spermiducal glands opening on to X; oviducts opening between X/XI; a protrusible penis; spermathecae in IX; spermatophores are formed.**

I do not see any way out of the acceptance of EISEN'S family of Eclipidrilidae for the very remarkable genus *Eclipidrilus;* VEJDOVSKY (**24**) refers it to the family Lumbriculidae, on account of the contractile appendages of the dorsal vessel and the characters of the setae. VAILLANT (**6**), too, is disposed to follow this course, 'at least provisionally.'

It is, I think, undoubtedly desirable, as VEJDOVSKY says, that the genital organs should be subjected to renewed examination; but in the meantime it seems to me that we are in possession of sufficient knowledge concerning the worm to warrant its inclusion in a family of its own, which should be placed between that of the Lumbriculidae and the Tubificidae.

The genus *Eclipidrilus* does, it is true, agree with the Lumbriculidae in the characters mentioned by VEJDOVSKY. The setae are most unquestionably identical in their character with those of the Lumbriculids. When, however, we turn to the other organs of the body, we find divergences from the Lumbriculid type of structure. This is especially the case with the male efferent apparatus, which, however, evidently requires re-examination. The long spermiducal glands communicate with a retractile penis, apparently very similar to that of the Tubificidae; the Lumbriculidae have no penis, with the exception of *Stylodrilus* and *Alluroides*, in which genera there are a pair of non-retractile penes, recalling those of certain Eudrilids. The spermiducal gland, too, is covered for part of its course with spirally-arranged muscular fibres, similar, as EISEN has remarked, to those of *Camptodrilus*.

It is in the middle that the gland is invested with these spiral muscles. And here its diameter is much narrower than elsewhere, dividing the entire tube into two divisions; in the lower part of the tube there are three apertures, placed one behind the other, by which its cavity communicates with the body-cavity; the walls of this tube are muscular, but the lining is, of course, epithelial. Freely suspended within this tube is another tube, which does not reach down so far as the first; at the point where it ends, a little way in front of the commencement of the penis, it has a circular orifice. The long sperm-sacs occupy about the same segments as the remarkable efferent ducts, i.e. x–xv. There appear to be three pairs of gonads, which EISEN calls 'ovaries,' in segments ix, x, xi. The nephridia have a swollen glandular part immediately after the funnel, as in other Lumbriculidae, Naidomorpha, and Tubificidae. There seem to be no specially enlarged hearts; those of segment x are extended backwards, no doubt in relation to the development of the sperm-sacs. There is but one species, viz. *Eclipidrilus frigidus*, from a spring in the Sierra Nevada of California, at an altitude of 10,000 feet. I attempt no definition of either species or genus.

FAMILY TUBIFICIDAE.

DEFINITION. Aquatic Oligochaeta of small size and slender build, fresh-water or marine. Setae of three kinds, capilliform, pectinate, and uncinate, the former two kinds, when present, found only in the dorsal bundles. Dorsal and ventral blood-vessels, connected by perivisceral trunks, in every segment of the body. Testes in X, ovaries in XI, sperm-ducts always terminating in spermiducal gland,

opening on to the eleventh segment. Oviducts open on to boundary-line XI/XII. Spermathecae one pair in X[1]. Penial setae sometimes present.

This family of Oligochaeta is plainly derived from (or has given origin to) the Naidomorpha. Indeed, the two are united by VAILLANT into one family, Naididae. The principal annectent genus is *Ilyodrilus*, formerly confounded with *Tubifex*, but now known, through the researches of EISEN (**12**) and STOLC (**3**), to be distinct. *Ilyodrilus* approaches the Naidomorpha principally by virtue of the structure of the nephridia and of the spermiducal glands, by the development of the ova, and by the relations of the intestinal vascular network. As in many Naids, a dark glandular swelling is developed upon the nephridium, immediately behind the septum; within this swelling the nephridial tube forms a network.

The spermiducal gland differs from that of most other Tubificidae in having neither 'prostate' nor penis; with it communicates a very short vas deferens, which is again a character found among the Naids. *Ilyodrilus* is, however, unmistakeably a Tubificid. The position of the sexual organs shows this, as well as the complicated vascular system. Nevertheless, it serves to indicate the nearest affinities of the family in one direction. In two species of *Hesperodrilus* there is a slight cephalization, so characteristic of the Naidomorpha. Affinities with other families of Oligochaeta are not yet clearly apparent.

The remarkable genus *Phreodrilus*, perhaps, indicates a passage to the Lumbriculidae. Its principal characters will be found below; I separate it a little from the other Tubificidae. In my account of the anatomy (**21**) of this worm I pointed out that it ought to be regarded as the type of a new family; I am not now disposed to separate it so widely. There is, however, it must be admitted, a considerable series of differences which distinguish the genus *Phreodrilus* from the Tubificidae; but rather greater differences distinguish the genus from other families of the aquatic Oligochaeta; and there are certain important resemblances to the Tubificidae, which are, perhaps, closer than any resemblances shown to the other groups of Oligochaeta; the chief resemblances to the Tubificidae are:—

(1) Dorsal setae capilliform.

(2) Spermiducal gland elongated without any thick glandular investment (but also without prostates).

(3) Supra-intestinal vessel present.

The two first characters, of course, are also those of the Naidomorpha. But, although I originally dwelt upon the likeness which *Phreodrilus* shows to that family, I am not now so impressed with this view of its affinities. It has, for example, yet to be proved that *Phreodrilus* is capable of multiplication by gemmation. The

[1] The position of the generative organs is abnormal only in *Hesperodrilus* (*q. v.*).

position of the reproductive organs is different to that of the Naids, though not, it is true, precisely that of the Tubificidae.

Phreodrilus is also not far removed from the Lumbriculidae in many points. The chief resemblance is in the fact that the spermathecae open behind the male pores, a resemblance which is shared by *Hesperodrilus*. It is possible also that the periatrial sac is comparable to the periatrial sperm-sac seen in *Sutroa;* the sigmoid setae are something like those of the Lumbriculidae. Other features of resemblance are dealt with in the section dealing with the general characters of the Lumbriculides (see above). The genus *Hesperodrilus*, which has just been referred to, shows a slight resemblance to the Lumbriculidae in that the first pair of nephridia occupy a considerable number of segments; the internal and external apertures of these lengthened nephridia are, however, as in the Lumbriculidae, in consecutive segments. We are at present evidently only very imperfectly acquainted with the extent of the range of structural variation in the family Tubificidae.

It contains sixteen distinct genera, which are the following:—

(1) **Tubifex**, LAMARCK.
(2) **Limnodrilus**, CLAPARÈDE.
(3) **Peloscolex**, LEIDY.
(4) **Clitellio**, CLAPARÈDE.
(5) **Hemitubifex**, EISEN.
(6) **Telmatodrilus**, EISEN.
(7) **Spirosperma**, EISEN.
(8) **Ilyodrilus**, EISEN.
(9) **Lophochaeta**, STOLC.
(10) **Bothrioneuron**, STOLC.
(11) **Branchiura**, BEDDARD.
(12) **Psammoryctes**, VEJDOVSKY.
(13) **Heterochaeta**, CLAPARÈDE.
(14) **Embolocephalus**, RANDOLPH.
(15) **Vermiculus**, GOODRICH.
(16) **Hesperodrilus**, BEDDARD.

The Tubificidae thus contain a very large number of genera in proportion to the species; to anyone who has looked through VAILLANT's work upon the Oligochaeta this statement will appear to be untrue; but it appears to me very doubtful whether the large majority of the species allowed by that author are really tenable; it will be seen, in the course of the following pages, that I have eliminated, and it is hoped with reason, a very considerable percentage of the described species; out of the sixteen genera ten have only one definable species each. I am very doubtful how far it is really justifiable to separate *Tubifex*, *Hemitubifex*, *Limnodrilus*, *Clitellio*, *Spirosperma*, *Camptodrilus* (included by VEJDOVSKY in *Limnodrilus*), and *Psammoryctes;* the latter is the most distinct, principally by reason of the peculiar setae attached to the spermathecae. There can be, on the other hand, no doubt about the distinctness of *Telmatodrilus*, *Ilyodrilus*, *Lophochaeta*, *Heterochaeta*, *Bothrioneuron*, *Hesperodrilus*, *Embolocephalus*, *Vermiculus*, and *Branchiura*. With regard to the first group, *Tubifex blanchardi* seems to differ more from *Tubifex rivulorum* than *Tubifex*

rivulorum does from *Limnodrilus*. In considering the question of the generic separation of these forms, it must be borne in mind that the comparatively simple organization of the family leaves less room for differences than in the highly organized 'Terricolae.' As all or nearly all the generic names have been in use for so long, and, as it is a less serious matter to multiply genera than to multiply species, I retain the names as they are at present. As to the species it is generally impossible to follow and compare descriptions by different authors. Minute points, emphasized by one, are neglected by another. What is wanted is a careful study of the living worms by one naturalist who is able to devote a good deal of time to what is, after all, a very small matter.

EISEN proposed (**12**) to divide the genera known to him into two sub-families, one containing the genus *Telmatodrilus* alone, the others the remaining forms.

They are distinguished by EISEN thus[1]:—

Subf. i. Telmatodrilus.

Setae sigmoid, only bifurcate in young.
Ventral nerve ganglia, distinctly paired, with numerous minute commissures.
Five pairs of contractile hearts (not more dilated than others) in vi–x.
Ventral vessel lateral in position approximated to dorsal.
Spermiducal gland with numerous (ten) separate prostates.

Subf. ii. Tubificini.

Setae both capilliform and uncinate.
Ventral nerve-ganglia not separated.
One to two pairs of contractile hearts in viii, ix.
Spermiducal gland with one large separate prostate, or without prostates.

To these subfamilies STOLC added two others, viz. Ilyodrilinae and Bothrioneurinae. He defines these subfamilies and the Tubificinae as follows[2]:—

Subf. i. Ilyodrilinae.

No penis. Penial setae present. Spermathecae without spermatophores.
No prostates. Development of ova as in Naidomorpha.

Subf. ii. Tubificinae.

Penis present, but no penial setae. Prostates present and spermatophores.
Development of ova as in higher Oligochaeta.

Subf. iii. Bothrioneurinae.

Penial setae present, but no penis. Male genital pore single and median.
Prostates present. No spermatheca.

If it were desirable to subdivide the family Tubificidae, my genus *Branchiura* would certainly form the type of a fifth subfamily. But it does not appear to me that much is to be gained by forming subfamilies in a family of so comparatively limited an extent as the Tubificidae.

As regards the mutual affinities of the genera comprising this family, we may arrive at a comparison of the genera by the help of the accompanying table, which shows the principal anatomical resemblances and differences.

[1] I abstract the two definitions from EISEN's two papers.
[2] As nearly as I can make out from the paper, which is in Czech.

	SETAE.	CONTRACTILE HEARTS.	SUPRA-INTESTINAL VESSELS.	INTEGUMENTAL NETWORK.	SUBINTESTINAL VESSEL.	PENIAL SETAE.	SPERMIDUCAL GLANDS.
Ilyodrilus	capilliform and uncinate	? none-periv. loops of v–x gradually increase in calibre	absent	present	absent	present	short and globular with narrow duct
Bothrioneuron	uncinate only	in vii, viii (intestinal) enlarged	present	present	present	present or absent	with continuous glandular covering, a diverticulum present
Telmatodrilus	uncinate only	perivisceral loops of vi–x		present		absent	numerous prostates
Limnodrilus	uncinate only	in viii, ix, (and x) those of viii very large[1]	present	rudimentary	absent	absent	with prostate
Clitellio	uncinate only	in viii, ix	present	absent			no prostate
Hemitubifex	capilliform and uncinate						with prostate
Spirosperma	capilliform, uncinate, and pectinate		present		present	absent	with prostate
Tubifex	capilliform and uncinate	in viii much enlarged (intestinal)	present	absent	absent	present or absent	with prostate
Lophochaeta	plumose, uncinate, and pectinate	in ix (intestinal) enlarged ? contractile	present	absent	present	absent	with prostate
Psammoryctes	capilliform, uncinate, and pectinate		present	absent	present	absent	with prostate
Heterochaeta	uncinate and palmate	in viii		absent		present	a prostate
Vermiculus	uncinate	in x				absent	without glands
Branchiura	capilliform and uncinate	v–x all contractile, last two enlarged	present	present		absent	a continuous glandular covering
Hesperodrilus	capilliform and uncinate	?	?	absent	?	absent	without prostate
Embolocephalus	capilliform and uncinate					present on x with a gland	with prostate

[1] In *L. novae-zelandiae* those of ix also are larger.

The distinctively Tubificid characters appear to be (1) the presence of two kinds of setae, capilliform and uncinate, and the frequent modification of the last to form pectinate setae; (2) a long spermiducal gland, with a protrusible penis and a prostate; (3) a supra-intestinal, in addition to a dorsal, vessel; (4) the contractility of at least one pair of the perivisceral trunks; (5) absence of penial setae.

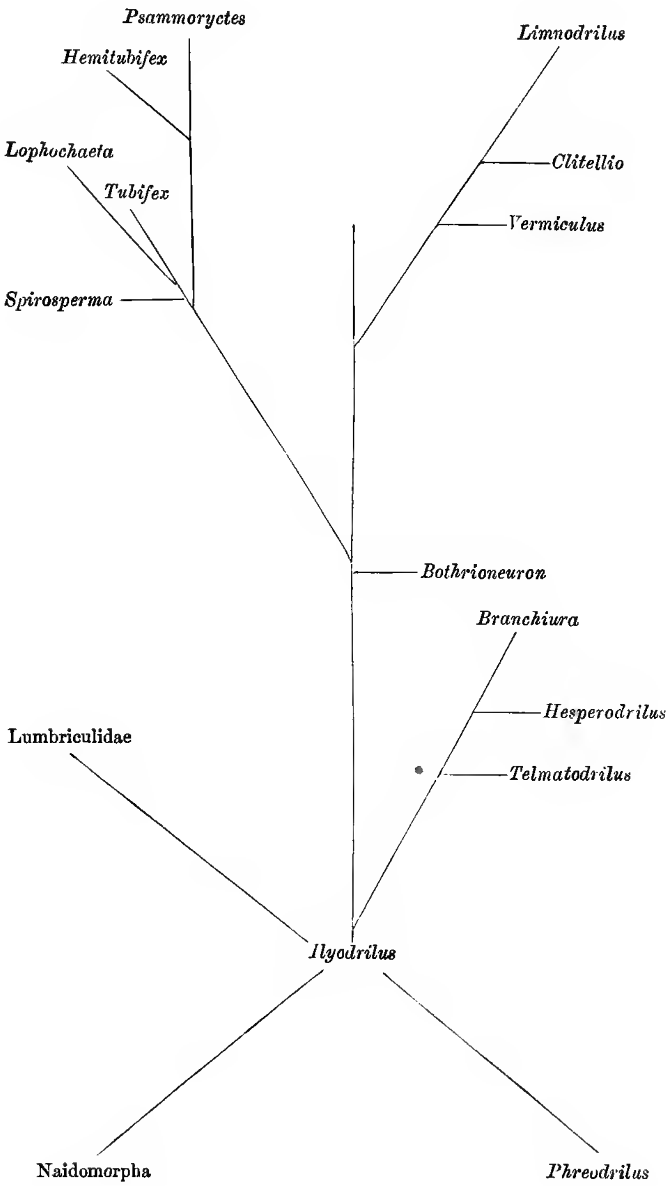
I should, therefore, regard the genera *Tubifex*, *Hemitubifex*, *Spirosperma*, *Psammoryctes*, and *Lophochaeta*, as occupying a central position in the family. So far as can be seen at present, *Ilyodrilus* is the simplest form of Tubificid, connecting this family with the Naidomorpha. It may be, therefore, placed at the base of the genealogical tree which indicates the probable relationships of the different genera. Simplification of structure is doubtless often due to degeneration; but the resemblance which *Ilyodrilus* shows to the Naidomorpha is not entirely due to the fact that it, like them, is a worm of simple organization. The simplification of the male efferent apparatus, absence of prostate and penis, might, indeed, be regarded from this point of view; but the connexion of the intestinal blood-plexus with the ventral vessel, the network formed by the nephridial tube immediately behind the funnel, and the presence of penial setae, are characters shared with the Naidomorpha which are by no means suggestive of degeneration; neither is the integumental blood-plexus.

Limnodrilus and *Clitellio* are so far specialized genera, in that they have lost the capilliform setae; the latter genus also has lost the distinctively Tubificid prostates. I should regard these forms as an offshoot, which has, however, progressed but a little way from one or other of the more typical genera. An attempt to fix the position of *Telmatodrilus* is more difficult. It shows certain resemblances to the very aberrant genus *Branchiura*, in the possession of several contractile perivisceral trunks, and in the integumental network. The last-mentioned character, as well as the absence of any specially dilated hearts, connects *Telmatodrilus* also with *Ilyodrilus*. Perhaps these characters indicate that *Telmatodrilus* has originated from the Tubificid stem a little before the acquirement of all the characteristic features of the group. *Branchiura* also must be looked upon (in my opinion) as a, comparatively speaking, primitive type. It has not lost the integumental network; the perivisceral loops of five or six segments are contractile, the spermiducal gland is like that of *Ilyodrilus*, but the relations of the gland to the vas deferens indicate a specialization, as do also the branchiae of the hinder segments. The same arguments apply to *Hesperodrilus*.

Bothrioneuron is also a much-specialized type, as is shown by the absence of spermathecae, and by the peculiar form of the prostates.

The mutual relations of the different genera, as I believe them to be, are indicated by the accompanying phylogenetic scheme.

Peloscolex is necessarily left out of consideration, as we do not know enough about it.



In all the Tubificidae the vas deferens of each side opens into a terminal chamber, which I propose to call the spermiducal gland, abandoning the term atrium ; a portion of this is commonly exsertile, and forms a penis. The simplest form of the gland is seen in *Ilyodrilus*; there is in *I. coccineus* (woodcut, fig. 39) a simple globular sac, which receives the sperm-duct; the sac is lined with ciliated epithelium, outside of which is a feebly developed layer of muscle, covered again by a mass of large granular cells. This suddenly narrows into a duct which leads to the exterior; it is not exsertile, but special muscles allow of the protrusion of this duct along with the epidermis of the body. Stolc figures (**3**, Tab. iii. fig. 1) a conical eminence of the body, well within which lies the duct. The resemblance of this chamber to that of the Naidomorpha and of the Lumbriculidae and Moniligastridae has already been pointed out.

Branchiura has an efferent apparatus which, besides possessing peculiarities of its own, is in some respects intermediate between *Ilyodrilus* and other Tubificidae.

The terminal chamber itself is apparently much as in *Ilyodrilus*, only the lining epithelium does not show any ciliation, and the other layers are thicker. The principal difference is that the vas deferens joins the atrial duct just above the penis. This is also the case in *Hesperodrilus*; this duct is long, and differentiated into two regions; it has at first a flattened, ciliated epithelium; this, changing abruptly, becomes taller, thrown into slight folds, and not ciliated. The whole duct is surrounded by muscles, and there is some evidence that the distal part of the tube is eversible. In any case the distal part of the tube, being of a different structure from the rest, may be termed the penis.

In all the remaining Tubificidae there is an extrusible penis, and the spermiducal gland is rather different in structure, being, moreover, in every case, except *Clitellio* and *Hesperodrilus*, furnished with one (*Tubifex*, *Limnodrilus*, &c.) or many (*Telmatodrilus*) prostates ('Cementdrüsen,' 'Kittdrüsen'). The simplest state of affairs is found in *Limnodrilus*, and, in fact, in all genera except *Tubifex*. In *Limnodrilus* the terminal chamber is long, narrow, and somewhat pear-shaped, being swollen where it receives the sperm-duct. Its lining epithelium, like that of the vas deferens, is ciliated; outside this is a layer of muscular fibres, and outside this, again, a peritoneal covering. At one side, near the upper extremity, is a lobate gland, the prostate, attached to it; this gland, which has been variously termed 'prostate,' 'Kittdrüse,' 'Cementdrüse,' 'vésicule seminale,' is solid and compact, and composed of pear-shaped granular cells; where it is attached to the terminal chamber, the muscular and peritoneal layers of the latter disappear, so that the cells of the gland are in actual contact with the epithelium of the terminal chamber. This is well shown in Claparède's figures (**2**, Pl. i. figs. 1 and 4) of *L. hoffmeisteri* and *udekemianus*.

CLAPARÈDE, NASSE, and DIEFFENBACH speak of a cavity, or, rather, several cavities within the lobes of the prostate, which unite to form the common duct of the gland which opens into the terminal chamber. The most detailed account of the lumina is given by DIEFFENBACH (for *Tubifex* indeed, but the conditions do not differ in *Limnodrilus*), and runs as follows:—

'Sie (die Kittdrüse) besteht aus einzelnen länglichen Drüsenlappen, die von der Mündungsstelle aus sich fächerförmig ausbreiten und in deren Mitte ein feiner Kanal verläuft, dem die einzelnen, stark granulösen, mit grossem Kern und Kernkörperchen versehenen Drüsenzellen aufsitzen. Ein Theil dieser Drüsenlappen lagert dem Atrium auf, die Drüsengänge derselben vereinigen sich mit den anderen zu gemeinsamer Mündung in das Atrium.' The figure, however (fig. 5 *pr.*), does not show these canals in by any means a convincing fashion, and there is no indication of them in the figures of any authors with whose papers I am acquainted.

VEJDOVSKY states that they develop as an outgrowth of the lining of the terminal chamber, and are thus products of the epidermis.

The distal extremity of the spermiducal gland is modified into a penis, enclosed by a sheath; the lining epithelium here is not ciliated. The penis itself is a direct continuation of the spermiducal gland. The sheath has an epithelial lining, and, outside of this, muscular walls, which have frequently a markedly spiral arrangement. The lining epithelium of the sheath secretes a chitinous layer, which encloses the penis. The development of this copulatory organ has been described by VEJDOVSKY (**24**, p. 143), and that briefly[1]. He says 'that the cavity of the penis arises by a secondary invagination; the sheath first appears, and then, after being invaginated, grows out again to form the penis. The penis and its sheath are therefore something superadded to the spermiducal gland, the original orifice of which would be at *a* in the figure.'

This description refers to *L. udekemianus;* it applies, however, to the two other European *Limnodrilus* in every point, except that they have a double coating of spiral muscles, the outer coat reaching beyond the penis-sheath for some distance along the narrow terminal region of the tube.

There are several other genera of Tubificidae in which the efferent apparatus only differs in detail from *Limnodrilus*. In *Spirosperma* there is a short strongly chitinous penis, and only a very slight development of muscles round the penis-sheath. So, too, *Lophochaeta* (fig. 38), where the chitinous sheath of the penis is less strong. These two genera have been described by STOLC (**3**).

[1] The account given by EISEN (12) is fuller, but substantially the same, apart from the curious views as to the 'oviduct,' for which see p. 238.

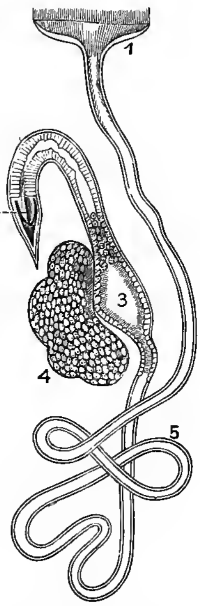
In *Hemitubifex* and *Psammoryctes* the upper end of the spermiducal gland, which is wider in most Tubificidae than the distal region, is more markedly dilated, and is constricted off from the rest to form a spherical chamber, receiving the vas deferens and prostate. This has been called the '*vesicula seminalis*.'

Bothrioneuron (fig. 40) has a peculiar efferent apparatus. The terminal chamber is wide, and is continuous above with the spermiducal gland, which is enveloped in a glandular sheath; about halfway down the prostate opens; this prostate (*paratrium* VEJDOVSKY calls it) is rather different in structure from the prostate of other Tubificidae. It consists of two parts: (1) of a pear-shaped diverticulum of the terminal chamber, lined with tall cells; (2) of a group of thicker cells, attached to the blind extremity of this. The two efferent ducts open (in *B. vejdovskyanum*) by a common median pore, a common enough arrangement in the family Eudrilidae, but rare in the aquatic families. Shortly before this common opening are (in *B. vejdovskyanum*) two diverticula, one containing penial setae. Bands of muscles are attached to the terminal part of the chamber, which is possibly protrusible. There is no penis as in the genera *Tubifex*, *Spirosperma*, &c.

The terminal efferent apparatus of *Tubifex* is like that of *Limnodrilus*; but the penis has a more complicated structure which has been especially studied by NASSE, DIEFFENBACH, and VEJDOVSKY (**24**). The latter has described its development, which is as follows. The first appearance of the spermiducal gland is a spherical invagination of the integument into which opens the vas deferens. This sac then lengthens, and the prostate arises from a thickening of the ciliated lining epithelium. The portion of the terminal chamber which lies nearest to the skin then becomes constricted off, and its epithelium breaks up 'into numerous elliptical and bright elements, which completely fill the cavity of the sac, so that only a with difficulty visible canal remains to put the newly formed chamber into communication with the exterior.' The further development of these bodies was not traced; but the penis and its sheath is probably a product of this distal part of the terminal chamber. In the adult worm the penis has a very complicated structure. As in *Limnodrilus* the canal of the penis is a direct continuation of the atrial canal, and there is a penis-sheath lined with epithelium and covered with muscles externally; this seems to have undergone a second folding, so that the retracted penis is enclosed by two sheaths; the inner of these secretes a thick, elastic, and, apparently, chitinous membrane, which is inserted on to the penis where the epithelium—the matrix of the chitinous membrane—becomes continuous with the epithelium of the penis itself. In *Tubifex* and in *Spirosperma* also the actual extremity of the penis is formed by a very thick mass of cells surrounding the

almost obliterated lumen. None of these genera possess penial setae, which are only found in *Ilyodrilus* and *Bothrioneuron*; indeed the ventral setae of the eleventh segment, upon which the male pores are situated are altogether absent from the sexually mature worm. It is not altogether easy to compare the efferent apparatus of the various genera of Tubificidae among themselves.

Fig. 38.

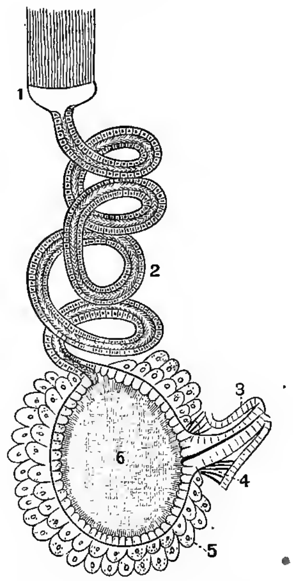


MALE EFFERENT APPARATUS OF LOPHOCHAETA.

(After Stolc.)

1. Funnel. 2. Penis. 3. 'Atrium.' 4. 'Prostate.' 5. Coiled sperm-duct.

Fig. 39.

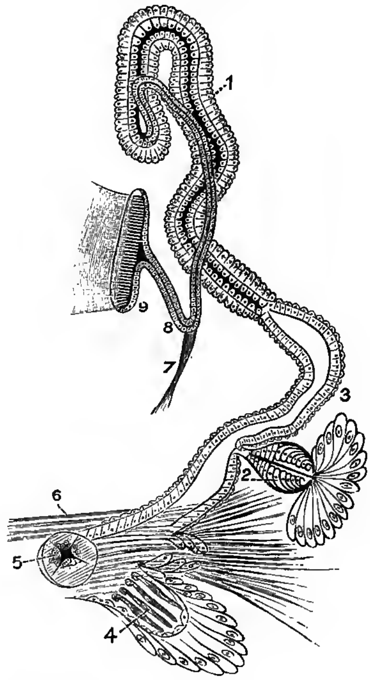


ILYODRILUS COCCINEUS. MALE EFFERENT APPARATUS.

(After Stolc.)

1. Funnel. 2. Sperm-duct. 3. Penis. 4. Muscles for its retraction. 5. Glandular covering of 6. 'Atrium.'

Fig. 40.



BOTHRIONEURON VEJDOVSKYANUM. MALE EFFERENT APPARATUS.

(After Stolc.)

1. Proximal region of 'atrium.' 2. 'Paratrium.' 3. Distal region of 'atrium.' 4. Penial setae. 5. External pore. 6. Muscles for protrusion of distal end of efferent apparatus. 7. Muscle attached to sperm-duct (8). 9. Funnel.

The simplest form is unquestionably that of *Ilyodrilus*, which leads to the Naids and Lumbriculidae.

If it were not for *Branchiura*, the more specialized chamber of *Tubifex*, &c., might be regarded as produced by further differentiation of the simple globular sac of *Ilyodrilus*, particularly since, as VEJDOVSKY pointed out, the complex terminal

chamber, with its appendages of *Tubifex*, originates as a simple sac, comparable to that in the lower forms.

In *Branchiura*, the sac which clearly corresponds to the terminal chamber of *Ilyodrilus*, no longer receives the sperm-duct; it has become merely a caecal diverticulum of the sperm-duct, which is specialized near to its termination into two sections, one ciliated, the other without cilia. The function of the vas deferens, with this terminal tube, is marked by a distinct narrowing of the vas deferens, and by a change in minute structure; at the junction opens the glandular sac.

It seems, therefore, to be possible that the tube lying between the end of the vas deferens and the exterior, and which corresponds to the duct of the globular sac in *Ilyodrilus*, is the equivalent of the entire copulatory apparatus in other Tubificidae. If this be so, it is then possible that the prostate of these Tubificidae is the homologue of the glandular sac of *Branchiura*, much reduced in importance and, except in *Bothrioneuron*, with a nearly or entirely obliterated lumen. However, it is more probable that the cells of the prostate of *Tubifex* represent a part only of the peripheral glandular layer of *Branchiura*.

As Benham (**15**) and I (**80**) have pointed out, the prostate in *Tubifex* is simply to be regarded as a portion of a continuous glandular covering such as exists in *Branchiura* and *Ilyodrilus;* an intermediate stage is offered by *Telmatodrilus*, in which genus the continuous glandular covering has already broken up into several separate glands. This probable explanation of the various conditions of the prostate in the Tubificidae does not do away with the possibility that the 'paratrium' of *Bothrioneuron* is the homologue of the large chamber in *Branchiura;* but it seems more probable that this 'paratrium' is a new structure.

In no Tubificid is there more than a single pair of spermathecae; and these organs are always (except in *Hesperodrilus*, where they are in the eleventh) situated in the tenth segment, i.e. that which also contains the testes. The spermathecae never have any diverticula, except a rudimentary one in *Hesperodrilus branchiatus*, but in a few species there are glands appended to the base of the pouches. Such glands, which are probably to be regarded as of epidermic origin, comparable to the capsulogenous glands of the genus *Perichaeta*, are found in *Hemitubifex insignis*, and in *Ilyodrilus sodalis* and *Psammoryctes barbatus*. In the latter worm the appendages are connected with a sac containing a single copulatory seta. The spermathecae of the Tubificidae differ somewhat in form in the different genera; in *Ilyodrilus* they are globular and sessile; in the great majority of species there is a division of the spermatheca into a pouch and a duct leading to the exterior; in *Lophochaeta*, for example, there is a change in the character of the lining epithelium which marks the commencement of

the duct; in many other forms this is still further emphasized by a constriction which divides the two regions of the spermatheca referred to; this constriction is especially well seen in *Clitellio*, in which genus both CLAPARÈDE and myself have figured it. In *Hemitubifex insignis* EISEN has figured the spermatheca as if there were cilia in the duct, but there is no mention of this in the text; they may be intended to represent spermatozoa; cases where the spermathecae are ciliated are extremely rare, and, perhaps, a little doubtful. However, NASSE distinctly asserts the presence of cilia in the duct of the spermatheca of *Tubifex*: 'Im Ausführungsgange trägt das Epithel eine Cuticula und flimmert.' On the other hand, VEJDOVSKY has denied this ciliation, nor is it figured by STOLC (3). Between the peritoneal coat and the lining epithelium, two muscular layers are developed, particularly at the end of the organ nearest to the opening; this region of the spermatheca can often, as in *Tubifex*, be extruded. The spermathecae often, as in *Clitellio* and *Hesperodrilus*, extend through several segments. *Bothrioneuron* has no spermathecae at all. The spermatophores have been already described.

The oviducts of the Tubificidae were first discovered by STOLC (4); this naturalist found them in the genera *Ilyodrilus* and *Psammoryctes*; a little later I found these organs in *Clitellio* and in *Hemitubifex*; later still STOLC figured the oviducts of *Bothrioneuron*; finally, I have found them in the genera *Branchiura* and *Hesperodrilus*. There is now a considerable probability that in all Tubificidae there are a pair of oviducts opening by a comparatively large funnel into the eleventh segment (or twelfth in *Hesperodrilus*), and on to the exterior on the boundary line between this segment and the following.

Previously to the discovery of the true oviducts a most curious view was prevalent as to the nature of the oviducts of the Tubificidae, which is of interest as an instance of the persistence of an error that had nothing in particular to recommend it; the view in question was in fact neither probable nor ingenious. They were originally believed to be connected with the male efferent apparatus; D'UDEKEM (6) described the egg-sac as a 'matrix,' communicating, on the one hand, with the ovaries, and, on the other hand, opening into the 'cloaca,' which was the name given by him to what we now call the atria; D'UDEKEM speaks of the 'matrix' opening into the cloaca, but in the next paragraph he states, and his statement is illustrated by a figure, that the wall of this sac forms the outer wall of the cloaca; hence the oviduct, according to this view, surrounds the atrium, which is thus invaginated in it. CLAPARÈDE (2) spoke of this description as being 'sans doute exacte'; but he limited his support of D'UDEKEM'S statements to the enclosure of the atrium within the oviduct; he denied any connection between the oviduct and the egg-sac.

VEJDOVSKY (13) originally ranged himself on the side of D'UDEKEM and CLAPARÈDE, and supported their views by his discovery of eggs passing out of the supposed oviducts; later, however, he gave reasons for believing that these bodies were not ripe eggs at all, but immature egg-cells detached from the ovary by the compression of the cover-glass, and abandoned the belief that the oviduct of the Tubificidae was in the position assigned to it by his predecessors. Granting

that the oviduct was as described by D'UDEKEM and CLAPARÈDE, VEJDOVSKY pointed out that it was difficult to understand the fixation of the penis; nor was he able to see the complicated layers round the penis, which were regarded by the authorities mentioned as representing the oviduct. EISEN (**12**), indeed, who accepted the views in question, still further increased the complexity of the subject by distinguishing between Tubificids with a single and Tubificids with a double oviduct; later, EISEN abandoned the distinction between the two kinds of oviducts, having discovered 'a minute penis-sheath' in Telmatodrilus, which was the only representative of the former class. LANKESTER threw doubts upon the interpretation of a part of the penis as an oviduct; and (also previously to the publication of VEJDOVSKY'S great work) did NASSE. The latter asked, as did VEJDOVSKY, as to the whereabouts of the attachment of the penis to the body-wall, if it was invaginated in the oviduct; he also considered that the end of the oviduct and the commencement of the penis were not clearly indicated by this way of supposing the oviducts to be outside the penis. DIEFFENBACH has devoted three or four pages of his studies upon the Limicolous Oligochaeta to a consideration of this question; he believed that 'most zoologists who have dealt with this question have been led along a wrong path by an incorrect observation of D'UDEKEM'S.' Some of DIEFFENBACH'S criticisms are really beside the point; he asks, for example, how it is that the ripe ova which lie in the sixteenth and seventeenth segments can press their way forwards to the eleventh; they must get nearly as far, in any case, for the true oviducts are between segments xi/xii. Their large size, too, would be as great an obstacle to their passage out by the real oviducts as by the supposed oviducts; DIEFFENBACH thought that the exit of the ova was by a partial tearing of the skin, an occurrence which he observed more than once; VEJDOVSKY, by treating the living worms, which were kept under observation the whole time with chemical reagents, noticed the ova to pass out between segments xi/xii; he is entitled, therefore, to the credit of having first discovered that the supposed oviduct of D'UDEKEM, CLAPARÈDE, and EISEN, performed no such function, but that the ova escaped from the body by the position just mentioned.

The form of the *brain* varies considerably in different genera of Tubificidae, and appears to be always complicated. The most distinctive feature is, perhaps, the anterior median process which is sometimes (as in the genus *Ilyodrilus*) a mass of cells continuous with the brain, and sometimes (as in *Bothrioneuron*) consists of a median nerve communicating with a small ganglion placed a little way in front of the brain (to be compared perhaps with the buccal ganglia of the Mollusca).

The *circulatory system*, which has been principally investigated by STOLC (**3**), is more complicated than in either the Lumbriculidae or the Naidomorpha. In many features it recalls the circulatory system of earthworms. The dorsal vessel is contractile, and runs from end to end of the body, on the dorsal side of the alimentary tract. *Branchiura* is the sole exception to this rule, and a very curious exception; the dorsal vessel in this worm is only dorsal in position as far back as about the tenth segment, from this point to the posterior extremity, it lies below the intestine, side by side with the ventral vessel. Anteriorly the dorsal vessel lies well above the oesophagus; in the intestinal region it is covered by the peritoneum of the intestine. Besides the dorsal vessel a good many Tubificidae have a supraintestinal vessel which has precisely the relations of the corresponding

vessel in earthworms. It lies in close contact with the oesophagus, beneath the peritoneum covering this organ. A supraintestinal vessel is present in the genera *Tubifex*, *Psammoryctes*, *Spirosperma*, *Lophochaeta*, *Limnodrilus*, *Bothrioneuron*, and *Branchiura;* it is absent in *Ilyodrilus;* with regard to the remaining genera there is no information. The supraintestinal vessel, as in many, if not in all, earthworms, is limited to the oesophageal region; it dies away gradually in front and behind.

The ventral vessel is present in all Tubificidae, and is quite free from the wall of the alimentary tract. It is (apparently always) non-contractile. Most Tubificidae (the genera *Bothrioneuron*, *Lophochaeta*, *Tubifex*, *Psammoryctes*, *Spirosperma*, and *Limnodrilus*) possess also a subintestinal vessel, corresponding, on the ventral side of the oesophagus, to the supraintestinal on the dorsal side. In *Bothrioneuron* and *Lophochaeta*, at any rate, this vessel communicates in front with the ventral vessel. The subintestinal vessel may, perhaps, be the equivalent of the intestino-tegumentary trunks of earthworms.

The dorsal and ventral vessels communicate, in nearly every segment of the body, by perivisceral arches. In the anterior segments of the body these are, as a rule, larger, and some of them are specially dilated, and constitute the so-called hearts. This, again, is a character met with in earthworms, as is also the contractility of some of the anterior perivisceral arches. In *Telmatodrilus* and *Branchiura* five or six pairs of these arches are contractile; these, in *Telmatodrilus*, gradually increase in calibre in successive segments from before backwards; in *Branchiura* those of ix and x are specially dilated. In the latter genus segment viii contains, in addition to the perivisceral loops connecting the dorsal and ventral vessels, a vascular arch, uniting the supraintestinal with the ventral vessel. In other Tubificidae there are one (*Tubifex*, *Lophochaeta*) or two (*Limnodrilus*, *Bothrioneuron*) contractile trunks, which pass round the oesophagus and unite the supraintestinal with the ventral vessel. The occurrence of these vessels is highly interesting. They evidently correspond to the 'intestinal hearts' of earthworms (*Pontodrilus*, *Perichaeta*, &c.) which put into communication the supraintestinal and ventral vessels (being sometimes, moreover, also connected with the dorsal vessel); and it will be noted that, as in earthworms, they are the last of the series, and are specially dilated.

In all Tubificidae the alimentary tract is surrounded by a network of blood-capillaries, which are derived, anteriorly from the supraintestinal, and posteriorly from the dorsal, vessel. In *Ilyodrilus*, as in the Naidomorpha, the intestinal network communicates with the ventral vessel by a pair of trunks in every segment. In other Tubificidae there seems to be no connexion between the intestinal network and the ventral vessel.

Very characteristic of the genera *Ilyodrilus*, *Branchiura*, and apparently *Telmatodrilus*, is the existence of an integumental network of which also traces exist in *Limnodrilus*. This, again, is a character which brings the Tubificidae into relation with the higher Oligochaeta. For the details of the circulatory system the reader is referred to the descriptions of the several genera.

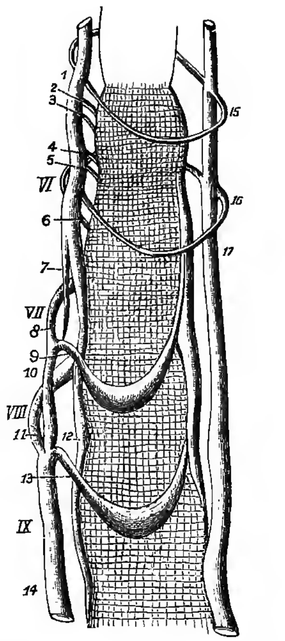
The two species, *Branchiura sowerbii*, and *Hesperodrilus branchiatus* are remarkable for the possession of branchial processes; these are paired structures, either dorsal and ventral (*Branchiura*), or lateral (*Hesperodrilus*) in position. They are found only upon the posterior segments of the body. Their structure has been dealt with above.

The Tubificidae may be divided into two sections, according as to whether the brown ovoid gland, so characteristic of the Naids, is or is not present. In the following genera it is present:—

Ilyodrilus.
Bothrioneuron.

In all the others it is absent;

Fig. 41.



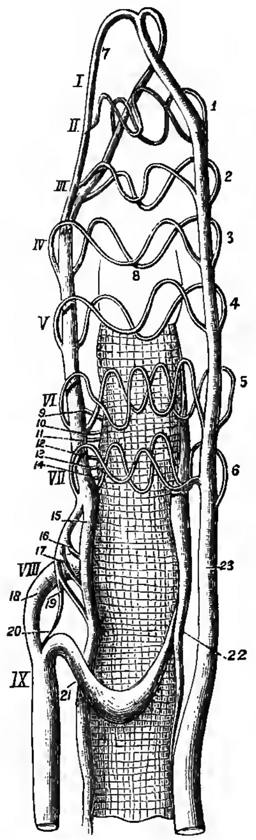
LOPHOCHAETA. VASCULAR SYSTEM OF SOME OF THE ANTERIOR SEGMENTS.

(After Stolc.)

1. Ventral vessel. 2–6. Vessels joining intestinal network. 7. Slender posterior part of ventral vessel just after it joins. 12. Sub-intestinal vessel. 9, 13. Intestinal hearts. 15, 16. Commissural vessels. 17. Dorsal vessel.

A

Fig. 42.



BOTHRIONEURON VASCULAR SYSTEM.

(After Stolc.)

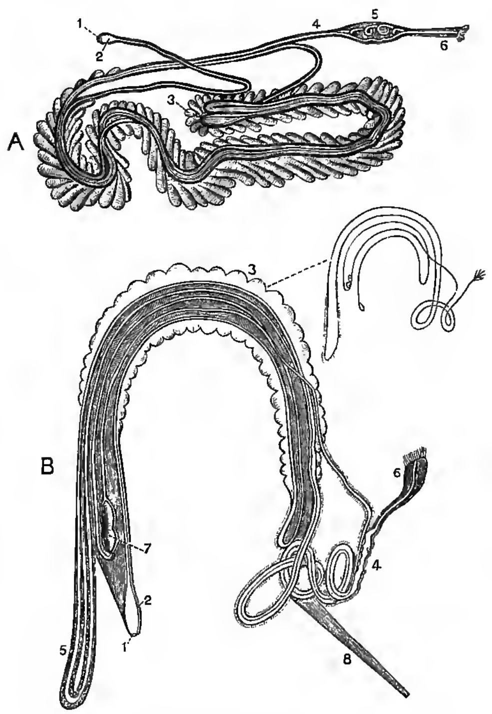
I–IX. Segments. 1–6. Lateral hearts. 7. Ventral vessel. 8. Pharynx. 9–14. Vessels supplying intestinal network. 15. Sub-intestinal vessel. 16–19. Vessels supplying intestinal network. 18, 21. Intestinal hearts. 22. Supra-intestinal vessel. 23. Dorsal vessel.

B

Stolc has figured these structures in the two genera mentioned, and his figures are

repeated here (woodcut, fig. 43); within this brown ovoid body the lumen of the nephridium divides into two channels, which give off a few branches; these, however, are not represented as anastomosing; the presence of this modified section of the nephridium affines the two genera in question to the Naids and to the Lumbriculidae. Although this glandular body is only properly developed in the two genera mentioned above, there are traces of it, according to STOLC's figure (**3**, Tab. ii. fig. 2), in, at any rate, one species of *Limnodrilus*, viz. *L. claparedianus*; in this worm the lumen of the nephridium immediately following the funnel is wider than it is behind and in front of this point, and is at the same time somewhat tortuous in its course (woodcut, fig. 43, B 4); there is, however, no network. The two genera, *Ilyodrilus* and *Bothrioneuron*, are further to be distinguished by the fact that in neither of them is there an ampulla such as occurs in *Limnodrilus* and (even more prominently) in *Spirosperma ferox* (EISEN, **12**, Pl. ii. fig. 2g. +); this ampulla is found in many earthworms.

Fig. 43.



NEPHRIDIUM OF ILYODRILUS (A) AND LIMNODRILUS (B).

After Stolc.

1. External pore 2. Vesicle. 3. Peritoneal coat. 4, 5. Glandular body. 6. Funnel. 7. Ampulla. 8. Muscular bands.

Genus TUBIFEX, LAMARCK.

Syn. Lumbricus, O. F. MÜLLER (in part.).
Saenuris, HOFFMEISTER.
Strephuris, LEIDY.
Blanonais, GERVAIS.
Nais, OKEN.

DEFINITION. Dorsal seta-bundles with capilliform, pectinate, and uncinate setae; ventral bundles with uncinate setae only. Dilated hearts in the eighth segment. No chitinous penis.

This genus, which may be taken as the type of the family, has been principally investigated by D'UDEKEM (**6**), CLAPARÈDE (**2**, **3**), VEJDOVSKY (**24**), MACINTOSH and STOLC (**3**); these investigations relate entirely to *T. rivulorum*, the best known species. The presence of capilliform setae in the dorsal bundles distinguish this genus from many other genera of Tubificidae, such as *Limnodrilus*, which has been by some authors confused with it. Besides the capilliform and uncinate setae, the first fifteen segments of the body contain pectinate setae much like those of *Psammoryctes*, but with the additional prongs less marked. Towards the end of the body the capilliform setae of the dorsal bundles disappear. The ventral seta bundles contain only uncinate setae. The cerebral ganglia have well marked[1] lateral lobes arising anterolaterally; posteriorly the brain is trifid with two larger lateral and one smaller central division.

A second species of the genus has lately been described by VEJDOVSKY (**8**); this worm differs in several particulars from the type species of the genus; it is indeed a little doubtful whether it is rightly included by VEJDOVSKY in the genus *Tubifex*. The principal external difference is in the absence of capillary setae; as, however, these are wanting in the posterior part of the body of *Tubifex rivulorum*, the difference is not perhaps so great; besides we know that *Hemitubifex* may, or may not possess capilliform setae in the dorsal bundles. The sexual orifices are stated by the describer of the species to be exactly as in *Tubifex rivulorum;* according to his figure, however, (**8**, Pl. xv. figs. 2, 3) the male-pores are upon the tenth segment instead of the eleventh, as in *T. rivulorum;* there is clearly no slip of the pen here, for in the description of one of the figures (fig. 4), the author expressly mentions the tenth segment as being that upon which the spermiducal glands open. Another external difference from *Tubifex rivulorum* is in the presence of 'penial' setae near to the orifices of the sperm-ducts and spermathecae; these exist in many Tubificidae, but not in *Tubifex rivulorum*[2]. As to the form of these setae VEJDOVSKY is unable to give any details; the extremities were broken off. In other respects there are no differences of more than specific value between the two species.

As to the possibility of *Ilyodrilus sodalis* being a *Tubifex*, I refer to the matter later. It differs from the other species, if it is correctly referred to this genus, in having pulsating vessels, not dilated, in segments viii–x.

[1] This description is from VEJDOVSKY.

[2] It must be remembered, however, that there is not certainly a difference here. VEJDOVSKY mentions that the sexual setae of this worm were broken. Now in *Tubifex rivulorum* there are the usual ventral setae at the male pores as at the female pores; it is quite possible, therefore, that the setae of *T. blanchardi* are merely ordinary setae. CLAPARÈDE (**2**, p. 23) refers to the existence of setae upon the segment bearing the male pores, which are placed a little in front of the setae. I have found them to persist in a species from New Zealand, which appears to differ in no way from *T. rivulorum* (= *T. bonneti*).

A very large number of species have been assigned to this genus, the names of most of which will be found as synonyms of species now known to belong to other genera, principally the littoral genus *Clitellio; Tubifex marinus* of LAMARCK (= *Lumbricus tubicola* of MÜLLER) is, according to VAILLANT, a *Clymene*.

The genus *Tubifex* is met with in Europe, North America, and New Zealand.

(1) Tubifex rivulorum, LAMARCK.

Lumbricus tubifex, O. F. MÜLLER, Verm. terrestr. 1774, p. 27.
Tubifex rivulorum, LAMARCK, Hist. An. sans Vert. 1816, iii. p. 225.
? **Strephuris agilis**, LEIDY, Journ. Acad. Nat. Sci. Philad. 1850, p. 45.
Nais tubifex, OKEN, Lehrb. d. Naturg. 1815, Pt. i. p. 364.
„ **filiformis**[1], DUGÈS, Ann. Sci. Nat. 1828, p. 286.
„ **sanguinea**, DOYÈRE, Mém. Soc. Linn. Norm. 1856, p. 306.
Tubifex bonneti, CLAPARÈDE, Mém. Soc. Phys. Gen. 1862, p. 230.
Saenuris variegata, HOFFMEISTER, De verm. quib. ad gen. Lumb. pert. Berlin, p. 9.
„ **tubifex**, JOHNSTON, Cat. Worms, 1865, p. 64.
„ sp. GEGENBAUR, Z. wiss. Zool. 1852, p. 227.
Blanonais filiformis, GERVAIS, Bull. Acad. Roy. Belg. 1838, p. 16.
? **Saenuris taurica**, CZERNIAVSKY, Bull. Soc. Nat. Mosc. 1880, p. 332.
? „ **peculiaris**, CZERNIAVSKY, Bull. Soc. Nat. Mosc. 1880, p. 333.
? „ **diversisetosa**, CZERNIAVSKY, Bull. Soc. Nat. Mosc. 1880, p. 334.
? **Tubifex campanulatus**, EISEN, Bih. Svensk. Akad. 1879, no. 16, p. 16.

Definition. *Brain concave in front with well-marked lateral lobes, posteriorly trifid with two longer lateral and one smaller central division. Setae of dorsal-bundles, capilliform, pectinate, and uncinate.*

As will be seen this species has a longer list of synonyms appended than almost any other Oligochaet. A strict adherence to the rules of Zoological nomenclature would necessitate the alteration of the commonly accepted name to *Tubifex tubifex*, if, that is to say, LAMARCK'S *Tubifex rivulorum* be identical with O. F. MÜLLER'S *Lumbricus tubifex*[2]. On the assumption that there is more than one species of *Tubifex* in Europe, which is at present far from being proved, there are no positive reasons either for affirming or denying the identity of species described by the older writers with *Tubifex rivulorum* of D'UDEKEM, VEJDOVSKY and others; there is, for example, nothing against their identification with EISEN'S *T. campanulatus*. It is perfectly clear, however, from O. F. MÜLLER'S description cited above that he is dealing with a *Tubifex* from his reference to

[1] It is not at all clear to what species WILLIAMS (1) refers under this name in describing the vascular system.

[2] CZERNIAVSKY (p. 330) does not allow LAMARCK'S *Tubifex rivulorum* to be the same as D'UDEKEM'S, nor, in spite of the description of the tubes, MÜLLER'S *L. tubifex*. *L. lineatus* of the latter author is identified with *T. rivulorum*, D'UDEKEM.

BONNET, who figures a recognizable *Tubifex*, and from the sentence 'seta anticc utrinque porrecta,' which I take to refer to the capilliform setae of anterior segments, and from his description of the tubes fabricated by the worm (also referred to in another work, 2, p. 100, note 28, and p. 102, note 29). No genus of Tubificidae, except *Tubifex*, has been stated to fabricate a tube (see, however, *Embolocephalus*). CLAPARÈDE'S species *T. Bonneti* is, as has been pointed out by NASSE, VEJDOVSKY, and others, identical with *T. rivulorum;* the principal point of difference used by CLAPARÈDE in distinguishing the species, viz the position of dilated contractile hearts in viii. instead of vii. is no doubt due to a wrong enumeration of the segments on the part of D'UDEKEM. DIEFFENBACH, though of opinion that the two 'species' are the same, uses the name *T. Bonneti*, which is hardly permissible. *T. rivulorum*, described by MACINTOSH, comprises, as he himself has pointed out, two species; one of these I believe to be an *Ilyodrilus;* the larger ('from the lakes' of Scotland) is, judging by the figure of the setae (pl. ix, fig. 3), identical with *Tubifex rivulorum*. LEIDY'S *Strephuris agilis* is doubtfully included by VAILLANT among the synonyms of *T. rivulorum*. VEJDOVSKY (24, p. 45) regards it as '*incertae sedis*,' and suggests its probable identity with one of the North American Tubificids described by EISEN (12). The position of the clitellum ('posterior to the ninth articulation'), and the form of the setae (figs. 6, 7) taken together argue that it is a Tubificid of some kind; the shortness of the oesophagus points in the same direction — but in *Tubifex* itself the oesophagus occupies only segments iii. and iv. (D'UDEKEM, VEJDOVSKY, NASSE), whereas in *Strephuris* it is said by LEIDY to reach the sixth segment. I therefore repeat VAILLANT'S query in my list of synonyms. VAILLANT includes among the synonyms *Ilyodrilus coccineus*, in spite of STOLC'S papers upon the structure of this worm, one of which is included by VAILLANT in his list of literature, and indeed partly abstracted (VAILLANT, p. 349). I do not include *I. coccineus* among the synonyms of *T. rivulorum*. With regard to *Saenuris taurica*, *S. peculiaris*, and *S. diversisetosa* (with two *vars.*), I am quite of the opinion of VAILLANT that they do not differ from *Tubifex rivulorum* as they are described by CZERNIAVSKY. At the same time I may point out that there is nothing in the latter naturalist's definitions[1] which militate against their transference to the genus *Hemitubifex* or *Ilyodrilus; T. diaphanus* of TAUBER, and *T. longicauda* of KESSLER are also possibly synonymous; as regards the former it is stated that the uncinate setae are 'nonpalmate'; this probably refers to the pectinate setae of *Psammoryctes umbelifer*. If the slight additional processes found in *T. rivulorum* were absent from this species it is probably an *Ilyodrilus* or *Hemitubifex*.

(2) Tubifex blanchardi, VEJDOVSKY.

T. blanchardi, VEJDOVSKY, Mém. Soc. Zool. Fr. 1891, p. 596.

Definition. *Length about 25 mm.; number of segments, 62. Setae of all bundles uncinate only. Hab.—Algeria.*

The setae of this worm, though they are everywhere uncinate, differ slightly in different regions of the body. The dorsal setae of the anteclitellian segment are equidentate, but there is occasionally a median denticle. The dorsal setae of the postclitellian segments have the superior denticle longer than the inferior; the same is also the case with the ventral setae of the same segments, but the ventral setae of the anterior segments are exactly the reverse. Sexual setae accompany the

[1] They principally relate to minute differences in the form of the uncinate setae.

orifices of the spermathecae and the atria, but there is no description to hand of their forms. That they differ from the ordinary setae whose place they take seems probable; in any case, those accompanying the male pores are arranged differently from the ordinary setae; VEJDOVSKY figures them (**8**, fig. 4) as lying one in front of the other.

Genus CLITELLIO, SAVIGNY.

Lumbricus, O. F. MÜLLER, &c. (in part.).
Peloryctes, LEUCKART.
Tubifex, D'UDEKEM (in part.).
Pododrilus, CZERNIAVSKY (in part.).
? **Psammobius**, LEVINSEN.

DEFINITION. **Uncinate seta only present. Dilated hearts in VIII, IX. No prostates. Spermatheca occupies four segments—X–XIII.**

In spite of CLAPARÈDE'S account of the structure of this genus and of *Limnodrilus* they are confounded by VAILLANT (**6**), who leaves out from his generic definition, as well as from the description of the species, *Cl. arenarius*, the characteristic difference between the two genera, viz. the absence (*Clitellio*) or presence (*Limnodrilus*) of prostate glands appended to the efferent apparatus, which he does not consider of sufficient importance to be a generic character. In an earlier work (**3**) VAILLANT had already taken up this position, which was accepted by CZERNIAVSKY. My own investigations upon *Clitellio* (**70**) being entirely confirmatory of CLAPARÈDE, besides adding a few details, emphasizing the necessity, I think, of keeping *Clitellio* and *Limnodrilus* separate. I showed, however, an additional point of resemblance between the two genera, i. e. the presence of *two* pairs of specially dilated 'hearts.' In the following table *Limnodrilus* and *Clitellio* are compared. It should be mentioned that *Cl. arenarius* is the only species whose anatomy is known[1].

CLITELLIO.	LIMNODRILUS.
Setae.—Entirely uncinate.	Ditto.
Hearts.—Two pairs in vii, viii, both enlarged, stretching through four segments when mature.	Ditto in viii, ix, last only enlarged (not in all species), limited to the tenth segment.
Integumental blood-capillaries.—Absent.	Present.
Vas deferens.—Comparatively short.	Long.
Spermiducal gland.—Without prostates.	With prostates.

[1] '*Clitellio ater*' is not a *Clitellio* (see below).

In a species of *Limnodrilus* from New Zealand there are two pairs of dilated hearts in precisely the same segments (viz. viii and ix) as those in which these hearts occur in *Clitellio*. This lessens the gap between the two genera. It should, however, be mentioned here that the specimens of *Limnodrilus novae-zelandiae* examined by me were sexually immature. It is therefore, perhaps, begging the question to refer them to the genus *Limnodrilus*, which I do on account of their fresh-water habitat.

VAILLANT (**6**) enumerates nine species of *Clitellio* of which some are apparently not referable to this genus; *Clitellio benedii* is, as is pointed out elsewhere, a *Hemitubifex;* MICHAELSEN (**5**) assigns *Clitellio lineatus* to the genus *Pachydrilus.* I discuss this view below. So, too, *Clitellio minutus.*

Clitellio inaequalis, described by O. F. MÜLLER as '*Lumbricus*' *inaequalis*, and doubtfully referred by GRUBE (**8**, p. 104) to this genus is a difficult species to come to any conclusion about. All that MÜLLER says about it is—'Papillis lateralibus simplicibus; setis solitariis.' VAILLANT justly remarks that these characters are 'trop succinctement donnés' to enable any conclusion to be drawn. The papillae obviously suggest *Hemitubifex benedii.*

Clitellio neurosoma of FREY and LEUCKART (p. 150) was referred by D'UDEKEM (**1**, p. 545, and **5**, p. 12) to the genus *Lumbriculus*—'à cause du développement des vaisseaux latéraux du système circulatoire.' These were described by the authors who named the species as being very long and much convoluted, especially in the anterior segments.

Clitellio tenuis was described by LEIDY as a *Lumbriculus* (**4**, p. 148); VEJDOVSKY (**24**, p. 51) places it among the Lumbriculidae but as 'incertae sedis.' VAILLANT (**6**, p. 421) doubtfully includes it in the genus *Clitellio.* The position of the genital orifices (? male-pores) upon the tenth segment (ninth in LEIDY'S enumeration) appears to justify its being put in the family Tubificidae, when taken in connexion with the fact that the setae are uncinate and 3-6 in a bundle. The habitat as VAILLANT remarks is also in favour of the correctness of this identification.

Clitellio irroratus of VERRILL (p. 324 and 622), called also a *Clitellio* by VEJDOVSKY (**24**, p. 45), queried by VAILLANT (**6**, p. 422), is I imagine not a *Clitellio;* as VAILLANT points out the presence of capilliform setae in the dorsal-bundles is against this identification; the fact that these setae are not always present suggests the genus *Hemitubifex.*

Clitellio dubius of CZERNIAVSKY (p. 327) might be almost anything; it is only known from a fragment of the hinder end of body. There remains only—

Clitellio arenarius, SAVIGNY.

Clitellio arenarius, SAVIGNY, Syst. d. Annél., 1820, p. 104.
Lumbricus arenarius, O. F. MÜLLER, Zool. Dan. Prodrom. 1776, p. 216.
Lumbricus littoralis, BRUGUIÈRE, Tabl. Encycl. 1791 [1].
Peloryctes arenarius, LEUCKART, Arch. f. Nat. 1849, p. 161.
Tubifex hyalinus, D'UDEKEM, Bull. Ac. Roy. Belg. 1855, p. 544.

[1] Fide VAILLANT.

Definition. *Length up to 30 m.; number of segments, 100; setae 2–6 in each bundle. Hab.—Coasts of Europe.*

Other characters those of genus.

LIMNODRILUS, CLAPARÈDE.

Syn. **Tubifex,** BUDGE (in part.).
Clitellio, VAILLANT (in part.).
Camptodrilus, EISEN.
Pododrilus, CZERNIAVSKY (in part.).
? **Acestus,** LEIDY.
Lumbriculus, LEIDY (in part.).

DEFINITION. **Fresh-water Oligochaeta with uncinate setae only. Contractile hearts in VIII or in VIII and IX. Perivisceral loops in posterior segments of body give off branches which penetrate body-wall. Penis with chitinous lining; prostates present.**

The genus *Limnodrilus* was first clearly defined by CLAPARÈDE (**2**). It had been confused by BUDGE and D'UDEKEM with *Tubifex.* BUDGE, for example, figures the chitinous penis of *Limnodrilus* in his paper dealing with *Tubifex rivulorum,* while D'UDEKEM, writing on the structure of the same worm, remarks upon the occasional absence of capillary setae; this appears to show that he had before him a *Limnodrilus,* for this is one of the principal differences between *Limnodrilus* and *Tubifex*[1]. I do not agree with VAILLANT'S inclusion of *Limnodrilus* within the genus *Clitellio;* the reasons for thus dissenting have been stated on p. 247. On the other hand it seems probable (as VEJDOVSKY and VAILLANT believe) that EISEN'S *Camptodrilus* is not really separable from *Limnodrilus.* It is distinguished by EISEN (**12,** p. 898) only on the grounds of the spiral arrangement of the fibres which surround the penis. 'In other respects,' he observes, 'this genus resembles *Limnodrilus.*' The question whether this be of sufficient importance as a generic mark need not be discussed, since VEJDOVSKY (**24,** pp. 48, 143) finds the same spiral arrangement in *Limnodrilus.*

As to *Pododrilus* of CZERNIAVSKY—the defective description of this author renders it impossible to be certain as to its identity (as VAILLANT thinks) with *Limnodrilus. Pododrilus* is not referred to by VEJDOVSKY. CZERNIAVSKY'S definition is as follows:—

'*Fasciculi* setarum omnes uncinis furcatis (4–2 vel 5–1) formati *anteriores* in duplicaturis prominentibus ("von einer kleinen Hautfalte getragen") positi Limicolae marinae.'

[1] Apart from *Tubifex blanchardi* (see p. 246 above).

This description, 'von einer kleinen Hautfalte getragen,' suggests, as VAILLANT points out (**6**) p. 413), the parapodia of the Polychaeta. I have, however, seen in *Limnodrilus* a series of wart-like protuberances, which bear the setae and may be the same structures. They certainly suggest rudimentary parapodia; for this reason I am inclined to admit *Pododrilus* as a synonym, not of *Clitellio*, but of *Limnodrilus*, though the marine habit of *Pododrilus* suggests rather that it should be included with the former genus.

Acestus of LEIDY was regarded by the author of the genus as but little different from *Lumbriculus*. His definition of the genus is as follows:—

'Body vermiform. Podal spines in 4 rows; anteriorly 3 to 8 in each fasciculus, posteriorly in pairs; long sigmoid, bifurcated at extremity. Upper lip conoidal, inarticulate. Annuli under 100. Blood red. Eyes, girdle, and muscular stomach none.'

Imperfect though this definition is, it clearly shows that *Acestus* is not a *Lumbriculus* (at least *auctorum; it is* identical with LEIDY'S *Lumbriculus*), or a Lumbriculid of any kind known. In the Lumbriculidae there are only two setae to each bundle. Its probable identity with *Clitellio* or *Limnodrilus*) was first pointed out by CZERNIAVSKY (p. 326), who also very justly ranged *Lumbriculus* (LEIDY *nec* GRUBE *et plurimorum auctorum*) under the same heading. In this he is followed by VEJDOVSKY (**24**, p. 45), but not by VAILLANT, who places *Acestus* under *Lumbriculus*, GRUBE, a proceeding which has no justification except on the view that LEIDY, who was acquainted with the real *Lumbriculus*, omitted from his definition facts which would show its identity with that genus.

The species of the genus *Limnodrilus*, so far as they are known, are invariably fresh water in habitat. The principal character of the genus, which distinguishes it from all other Tubificidae except *Clitellio*, is the presence of uncinate setae only; it is distinguished from *Clitellio* by the presence of a prostate and by the great length of the narrow and much-coiled vas deferens. The chitinous penis, which is longer in some species than in others, distinguishes *Limnodrilus* from *Tubifex*. A character which is peculiar to *Limnodrilus* is the presence of vascular tufts penetrating the epidermis; these are given off (in the posterior region of the body) from the peri-intestinal vessels; a branch arising from each of these loops, near the middle, dilates into a sinus covered externally with pigmented cells; from this sinus four or five capillaries penetrate the integument as far as the middle of the epidermis, and then appear to end blindly.

The three European species, *L. udekemianus*, *L. hoffmeisteri*, and *L. claparedianus*, can be readily distinguished, but it is not always so easy to make out the American species described by EISEN (in **7** and **12**). The form of the brain and the comparative length of the chitinous penis sheath appear to be the most salient characters; but, as in some cases, there is not an agreement between EISEN'S figures and those of other authors (compare for example the figures of the brain of *Spirosperma ferox*, given by EISEN and STOLC respectively), a certain amount of doubt necessarily arises as to the value which can be legitimately attached to these characters. A revision of the genus would probably reduce the species considerably.

The genus *Limnodrilus* as above defined contains a considerable number of species from Europe and from N. America. I have received examples also from New Zealand and from Hawai[1]. The following twelve species are perhaps recognizable :—

1. **Limnodrilus hoffmeisteri,** CLAP., Europe.
2. „ **udekemianus,** CLAP., Europe.
3. „ **claparedianus,** RATZEL, Europe.
4. „ **ornatus,** EISEN, California.
5. „ **steigerwaldi,** EISEN, California.
6. „ **monticola,** EISEN, California.
7. „ **alpestris,** EISEN, California.
8. „ **silvani,** EISEN, California.
9. „ **spiralis,** EISEN, California.
10. „ **igneus,** EISEN, California.
11. „ **corallinus,** EISEN, California.
12. „ **californicus,** EISEN, California.

A number of others are not recognizable.

Tubifex elongatus, D'UDEKEM (Bull. Ac. Roy. Belg. t. xxii. 2nd pt. p. 544) from the definition—'Téguments transparents; corps mince très allongé; des crochets fourchus dans tous les faisceaux. Habite les eaux douces'—appears to be a *Limnodrilus.* It occurs in neighbourhood of Brussels and is to be distinguished from *Tubifex rivulorum* with which it lives by absence of capilliform setae.

In spite of the impossibility of recognizing this species from the description, TAUBER (1, p. 71) records its occurrence in Denmark. LEVINSEN (2, p. 225) includes it under *L. udekemianus,* and *L. hoffmeisteri,* following CLAPARÈDE (2, p. 71, footnote 2), who considers it to be perhaps synonymous with one or other of these species. This view is also held by VEJDOVSKY (24, p. 44).

'*Clitellio suchumicus,*' CZERNIAVSKY, Bull. Mosc. 1880 (p. 328) is probably a *Limnodrilus* as it has uncinate setae (3 in anterior bundles, 2 behind) and no others, and occurs in fresh water along with *Tubifex.* It is not worth while to repeat the long Latin diagnosis given by CZERNIAVSKY, as this contains no facts of importance save those mentioned. CZERNIAVSKY remarks that 'it is met with in great numbers in shallow river of Suchum, under stones, particularly where it crossed a road.' The few setae in each bundle may perhaps distinguish the species.

'*Clitellio heterosetosus,*' CZERNIAVSKY (ibid. p. 328) is not defined in such a way as to render its identification possible, though there seems to be no doubt about its being a *Limnodrilus.* In possessing six or seven setae in each of anterior bundles it is a more normal *Limnodrilus* than the last.

'*Nais gigantea,*' KESSLER, Trud. Russk. Est. St. Petersb., 1868, is regarded by VEJDOVSKY as a *Limnodrilus.*

'*Saenuris abyssicola,*' SMITH and VERRILL, Am. Journ. Sci. Arts, 3rd ser. vol. ii. p. 449. This worm is stated to consist of twenty-eight segments; 'anus terminal with three or four slight lobes'[2];

[1] These were collected by Mr. R. C. L. PERKINS; I cannot differentiate them from the American *Camptodrilus.*

[2] This is perhaps a little suggestive of the branchiae of *Branchiura.* I observed one specimen of this worm in which there were only two or three close to the anus.

there are five or six setae in each fascicle 'simple acute, slightly curved'; in one specimen there were four minute ocelli.

This species, which is obviously insufficiently described, is included by VEJDOVSKY among the Tubificidae, and is doubtfully regarded by VAILLANT (**6**, p. 433) as a *Limnodrilus*. It is not stated, however, that the setae are uncinate, and therefore MICHAELSEN may possibly be right (**5**, p. 50) in placing it among the Enchytraeidae; he remarks with regard to this and the following species 'diese beiden Verril'schen Arten müssen den Enchytraeiden zugeordnet werden, da sie einfach zugespitzte Borsten haben.'

'*Saenuris limicola*,' SMITH and VERRILL, Am. Journ. Sci. Arts, 3rd ser. vol. ii. p. 450, consists of forty-four segments; 6–8 setae in each fascicle anteriorly, 4–5 posteriorly; setae 'long, slender, curved, and acute.'

This species, again referred to the Tubificidae by VEJDOVSKY, and to *Limnodrilus* doubtfully by VAILLANT (**6**, p. 434), is put by MICHAELSEN among the Enchytraeidae. In favour of this placing of the species and the last, in addition to the form of the setae emphasized by MICHAELSEN, is the fewness of the segments of which the body is composed.

'*Saenuris vagans*,' JOHNSTON, Cat. Worms, B. M., pp. 65, 353. This species is doubtfully included by VEJDOVSKY (**24**, p. 46) as a synonym of *Tubifex rivulorum*. VAILLANT, as I think, with more probability regards it as possibly a *Limnodrilus*. So far as the definitions given by JOHNSTON, and in the appendix to the 'Catalogue of non-parasitical worms' by BAIRD go, and this is naturally not very far, this is the only conclusion that could be safely arrived at. The setae are, however, described as 'acute at the outer extremity,' and there is no mention of a bifid tip. It is probably this which has led MICHAELSEN to include the species[1] (**5**, p. 53) among the Enchytiaeidae, as well as its small size (6‴), and the fewness of the segments (50) of which the body is composed.

Tubifex uncinarius of DUGÈS possibly belongs here, and *T. deserticola* and *Limnodrilus bogdunovii* of GRIMM.

In conclusion, I may briefly refer to the existence of this genus in Hawai, where it is represented by a species which shows the remarkable spiral disposition of the muscular fibres round the spermiducal gland. The specimens were obtained from a spring on a mountain, but I cannot distinguish any marked peculiarities which justify me in giving it a new name, though on the other hand I have not yet identified it with any of the known forms. Living material is essential for the proper description of these Tubificids.

(1) Limnodrilus claparedianus, RATZEL.

L. claparedianus, RATZEL, Z. Wiss. Zool. 1868, p. 590.
Camptodrilus spiralis, EISEN, Bih. K. Svensk. Akad., 1879, No. 16, p. 22.
Camptodrilus californicus, EISEN, loc. cit., p. 24.
Tubifex rivulorum, BUDGE, Arch. f. Nat. 1850, p. 1 (in part.).
Clitellio (Limnodrilus) claparedianus, VAILLANT, Annelés, p. 424.

[1] But no mention is made of the cleft extremity of the setae of *T. rivulorum* by JOHNSTON; the neglect, therefore, to mention this fact with reference to the setae of '*Saenuris vagans*' is not an argument that the setae indicate the Enchytraeid family.

Definition. *Length about* 50–70 *mm. Brain almost square with squarish cleft behind; anterolateral lobes, each divided into two, one directed forwards the other backwards. Pharynx reaches into fifth segment. Chitinous penis eight to ten times as long as broad. Hab.—Europe; California; San Francisco; and Sierra Nevada.* 7,000.

I associate EISEN'S two species, *Camptodrilus spiralis and C. californicus*, with RATZEL'S *Limnodrilus claparedianus* in deference to the opinion of VEJDOVSKY; but the definitions given by EISEN appear to show differences between *L. spiralis* and *L. californicus*.

As regards the European forms *L. claparedianus* differs from the other two by the much greater length of the chitinous penis sheath; the worm itself is also much longer. These facts were pointed out by its original describer, RATZEL, though the same facts about the penis sheath can be gathered from an inspection of BUDGE'S plate. DIEFFENBACH (p. 98) puts down the proportions between the length and breadth of the penis as sometimes 30 : 1, and states that in the length of this sheath there are intermediate stages between *L. hoffmeisteri* and *L. claparedianus*. DIEFFENBACH is, however, not accurate in saying that these two species in other respects show an identical structure, for they differ, among other points, in the form of the brain—as may be seen by the figures illustrative of this organ given by VEJDOVSKY (**24**, Tab. viii, fig. 14), and STOLC (**3**, Tab. i, fig. 7). The pharynx too extends farther back in *L. claparedianus* than in *L. hoffmeisteri*.

(2) Limnodrilus hoffmeisteri, CLAPARÈDE.

L hoffmeisteri, CLAPARÈDE, Mém. Soc. Phys. Gen. 1862, p. 248.
Clitellio (Limnodrilus) hoffmeisteri, VAILLANT, Annelés, p. 424.

Definition. *Length about* 35 *mm.; number of segments* 95. *Brain square, with shallow excavation posteriorly. Pharynx reaches into third segment. Nephridia with vesicular cells. Penis six to seven times as long as broad. Hab.—Europe.*

This species has been chiefly described and illustrated by CLAPARÈDE and VEJDOVSKY (**24**), who thinks that DOYÈRE described it under the name of *Nais sanguinea*.

(3) Limnodrilus udekemianus, CLAPARÈDE.

L. udekemianus, CLAPARÈDE, Mém. Soc. Phys. Gen., 1862, p. 243.
Clitellio (Limnodrilus) udekemianus, VAILLANT, Annelés, p. 425.

Definition. *Length about* 60 *mm. Brain with median and lateral lobes posteriorly, with paired anterior and anterolateral lobes. Pharynx reaches into fifth segment. Penis about three times as long as broad. Hab.—Europe.*

(4) Limnodrilus ornatus, Eisen.

L. ornatus, Eisen, Bih. K. Svensk. Akad., No. 16, 1879, p. 17.

Clitellio (Limnodrilus) ornatus, Vaillant, Annelés, p. 426.

Definition. *Length about* 30 *mm. Brain with shallow concavity posteriorly. Spermathecae pear-shaped, sometimes constricted in middle. Penis about five times as long as broad. Nephridia without large globular peritoneal cells. Hab.—California; San Joaquim river.*

The 'principal characteristic' of this species is, according to Eisen, 'the star-like concretions round the upper end of the penis sheath.' His figure (**12**, Pl. ix, 8 d *crn*) shows that these bodies are attached to the upper extremity of the penis just where it becomes continuous with the penis sheath ('Penisscheide,' Vejdovsky, *not* 'penis sheath,' Eisen). I do not understand what these structures are. Vejdovsky only doubtfully allows this species to be a *Limnodrilus.*

(5) Limnodrilus steigerwaldi, Eisen.

L. steigerwaldi, Eisen, loc. cit., p. 18.

Clitellio (Limnodrilus) steigerwaldi, Vaillant, loc. cit., p. 427.

Definition. *Length about* 80 *mm*[1]. *Brain with marked concavity posteriorly, wider in front than behind, and prolonged into lobes anteriorly. Spermathecae narrow and pear-shaped; penis about as long as in last species. Nephridia without globular peritoneal cells, except just behind funnel. Hab.—California; Sierra Nevada.* 7,000 *ft.*

This species is to be distinguished from the last by its greater size and more complex brain. Vejdovsky again only doubtfully includes it in the genus *Limnodrilus.*

(6) Limnodrilus monticola, Eisen.

L. monticola, Eisen, loc. cit., p. 18.

Clitellio (Limnodrilus) monticola, Vaillant, loc. cit., p. 427.

Definition. *Length about* 30 *mm. Brain much as in L. ornatus, but squarer. Spermathecae cylindrical, sometimes with slight constriction. Penis about eight times as long as broad, truncated at extremity. Hab.—California; Sierra Nevada.* 9,000 *ft.*

The truncated extremity of the chitinous sheath of the penis is, according to Eisen, the most characteristic mark of this species. It should be noted, however, that Dieffenbach (Pl. ii, fig. 1) figures a similar truncation in *L. hoffmeisteri.*

[1] Stated by Eisen in (**12**, p. 895) to be 30 m. by an evident misprint.

(7) Limnodrilus alpestris, Eisen.

L. alpestris, Eisen, loc. cit., p. 19.

Clitellio (Limnodrilus) alpestris, Vaillant, loc. cit., p. 428.

Definition *Length about* 25 *mm. Brain wider behind, sometimes trilobed. Nephridia with vesicular cells. Spermathecae wider at both extremities than in the middle, coiled at the upper extremity. Chitinous penis sheath about eight times as long as broad, trumpet shaped at extremity. Hab.—California; Sierra Nevada.* 7,000 *ft.*

The shape of the brain and of the extremity of the chitinous penis are stated by Eisen to be the distinguishing marks of the species.

(8) Limnodrilus corallinus, Eisen.

Camptodrilus corallinus, Eisen, loc. cit., p. 23.

Clitellio (Limnodrilus) corallinus, Vaillant, loc. cit., p. 431.

Definition. *Length* 25–70 *mm. Brain nearly square, with square cleft behind; anterolateral processes well developed. Nephridia in front of clitellum with, behind clitellum without, vesicular cells. Spermathecae wide and globular without narrow duct. Chitinous penis sheath eight times as long as broad. Hab.—California; Fresno county.*

The presence of vesicular cells surrounding the nephridia in the anterior segments, but not of the posterior segments, is a character which this species shares with *L. hoffmeisteri;* the form of the brain in the two species is evidently not unlike, though that of *L. hoffmeisteri* (Vejdovsky, **24**, Taf. viii, fig. 14) want the deep and square posterior cleft.

(9) Limnodrilus silvani, Eisen.

L. silvani, Eisen, loc. cit., p. 19.

Clitellio (Limnodrilus) silvani, Vaillant, loc. cit., p. 428.

Definition. *Length* 180 *mm. Brain wider than long, and wider behind than in front, sometimes furnished with three posterior lobes. Nephridia without vesicular peritoneal cells. Spermathecae wider at extremities. Chitinous penis, only three or four times as long as broad. Hab.—San Francisco.*

This species is described by Eisen as occurring in two varieties; one is very much longer than the other. In the above definition the longer form only defined; the smaller worms (50 mm. in length) occur with the bigger; their brain is longer than wide and never trilobed; the spermatheca is straight. As intermediate forms are found (though rarely) Eisen unites them into one species.

(10) Limnodrilus igneus, EISEN.

Camptodrilus igneus, EISEN, loc. cit., p. 23.

Clitellio (Limnodrilus) igneus, VAILLANT, loc. cit., p. 430.

Definition. *Length about 30 mm. Brain deeply cleft in front and behind; the two anterior lateral processes of the brain marked by several protuberances, broader in front than behind. Nephridia with vesicular peritoneal cells. Spermathecae wide distally; expanded at its extremity. Penis at least ten times as long as broad. Hab.—San Francisco.*

Genus HESPERODRILUS, BEDDARD.

DEFINITION. Dorsal seta bundles with capilliform setae only; ventral setae uncinate and simple, one of each kind in a bundle. Clitellum XII–XIII; male pores on XIII, spermathecae open on XIII. No prostate.

This genus is at present known only from South America, whence I have described four species. The genus, though agreeing in general appearance with *Tubifex* and other Tubificidae (the resemblance is not so marked in the case of *Hesperodrilus niger*), is one of the most distinct of the genera of this family. As regards external characters the position of the clitellum and of the generative pores differs from all other Tubificidae—if we assign to that family, and except only, *Phreodrilus*. The segments occupied by these various structures are one further back than is usual. The setae of the ventral bundles are remarkable for the fact that in each bundle there is one uncinate seta and one whose extremity is not bifid. In two species, viz. *H. albus* and *H. pellucidus*, the dorsal setae are wanting upon the first setigerous segment, thus recalling the state of affairs so characteristic of the Naidomorpha. The internal structure is chiefly remarkable for the fact that the sperm-duct does not open into the summit of the spermiducal gland, but opens in common with this gland into the base of the protrusible penis. There are no distinct prostates; nor is the absence of these compensated for by the presence of a thick glandular covering such as occurs in *Branchiura*. The spermathecae are abnormal in opening on to the exterior behind the male pores—a quite unique occurrence in the family excepting again only *Phreodrilus*. Coupled with the absence of prostates, there are no spermatophores. Of the four species of this genus two come very close together, viz. *H. albus* and *H. pellucidus*. The species can be discriminated by the following scheme:—

(1) Setae absent from dorsal region of first two segments:

a. Spermiducal gland with narrow duct leading to penis. *H. albus.*

b. Spermiducal gland without this duct. *H. pellucidus.*

(2) Setae present upon all segments after the first:

a. Posterior end of body with branchiae. *H. branchiatus.*

b. No branchiae. *H. niger.*

(1) Hesperodrilus albus, Beddard.

H. albus, Beddard, Ann. Mag. Nat. Hist. Feb. 1894, p. 209.

Definition. *Setae of dorsal bundles commence in segment III. Spermiducal gland opens into penis by a moderately long, narrow, non-glandular duct. Hab.—Port Stanley, Falkland Islands, in a pond.*

This species, in the preserved condition, was quite white; hence the specific name. It is about the size of a *Tubifex*. The intestine begins in xix. The first pair of nephridia, which occupy segments vi–x, open on to the exterior in vi. The condition of this first pair—and they are the same in the following species—recalls a characteristic feature of the *Lumbriculid Phreatothrix*. The spermathecae are very peculiar—apart from the position of their external pore. They are very long, extending through five segments. The blind extremity is dilated into an oval sac; in which part of the organ alone was sperm to be found. Then follows a narrow duct which runs in a fairly straight course, being in one specimen wound round the corresponding part of the spermatheca of the opposite side of the body. In the middle of this is a kind of trap formed by a sudden increase in the height of the lining epithelium, and diameter of the tube, which projects forward, and would tend to prevent the sperm from moving except in one direction, i. e. towards the blind end of the sac. After the narrow part of the tube it widens out into a terminal chamber, which opens on to the exterior in the unusual position already referred to. The spermiducal gland is not large; it ends in a thin tube lined by a non-glandular lining which opens into the penis. In one individual the clitellum occupied segments xi, xii, the normal segments for the Tubificidae. The entire spermiducal gland can be everted, and the penis thus formed is very long. There were ripe ova in segments xviii–xx, or in xxi, xxii.

(2) Hesperodrilus pellucidus, Beddard.

H. pellucidus, Beddard, loc. cit., p. 210.

Definition. *Setae of dorsal bundle commence in III. Setae of dorsal bundles shorter and more slender than in last species. No long duct, only a constriction separates spermiducal gland from penis. Hab.—Uschuia, S. America.*

This species exactly resembles the last, except in the points noted in the above diagnosis and in the pale brown colour of the preserved worms.

(3) Hesperodrilus niger, Beddard.

H. niger, Beddard, loc. cit., p. 208.

Definition. *A stout species, black in colour. Dorsal setae begin upon first setigerous segment. Hab.—Port Stanley, Falkland Islands.*

This worm has very much the appearance of a *Lumbriculus.* It is much stouter than either of those described. The black colour is due to pigment, which is chiefly deposited in the peritoneum dorsally, extending into the musculature and also a little way along the septa. The dorsal setae are rather slender. It is a curious point about this worm that the spermiducal gland, though confined to the twelfth segment, pushes the septum xi/xii before it so that it comes to lie as it were partly in segment xi. This out-pushing of the septum in question begins when there are as yet no signs whatever of the gland itself.

(4) Hesperodrilus branchiatus, Beddard.

H. branchiatus, Beddard, loc. cit., p. 207.

Definition. *Last thirteen segments with a series of paired gills, attached a little below the lateral seta bundles. Spermathecae with a slight diverticulum at orifice. Hab. —Valdivia, Chili.*

This species is the only other Tubificid besides *Branchiura,* which has gills; these will be found more particularly described above (p. 84). The specimen which I examined consisted of fifty-three segments, and was about three-quarters of an inch long. I could find no proper sperm-sacs such as exist in the other species and in other Tubificids. The sperm lay loose in the cavity of segments vii–xi.

Genus HETEROCHAETA, Claparède.

Definition. **Setae uncinate, except dorsal setae of V–XIII, which are mainly palmate. Dilated hearts in VIII. Spermiducal gland divisible into two regions; the glandular region (vesicular) not dilated; penis chitinous; prostates present.**

This genus, originally described by Claparède (4), has been more fully dealt with by Benham (9). It is mainly to be characterized by the peculiar palmate setae which Claparède erroneously referred to as cup-shaped. They are in reality

better termed 'fan-shaped'; the free end is expanded, and apparently cleft into about seven 'teeth.' These are, however, united by a delicate membrane. As the absolute extremities of the teeth are bent over all in one direction, the shape of the setae is highly suggestive of that of a rake. There is but one species:—

Heterochaeta costata, Claparède.

H. costata, Claparède, Beobacht. wirbell. Thiere, 1863, p. 25.

Definition. *Length about* 15 *mm.; number of segments about* 40. *Ventral setae of anterior segment and dorsal setae of II–IV have the prongs nearly equal; in dorsal and ventral setae of posterior segments lower prong shorter than upper; number of setae in a bundle,* 4 *(II) to* 14 *(VIII) dorsally; in ventral bundles,* 1 *(XXV) to* 5 *(V). Hab.—Coasts of England and Belgium; Marine.*

There is a certain amount of variation in the arrangement of the setae. The palmate setae sometimes extend further. There has, however, been no detailed study of these variations. Setae of the pectinate variety occasionally occur, but, apparently, so rarely that their occurrence cannot be regarded as either a generic or a specific character. The species is fully illustrated in Benham's memoir, and a few figures are given by Claparède.

Genus PELOSCOLEX, Leidy.

Definition. Each segment with a circle of prominent tubercles. Dorsal setae entirely capilliform, ventral setae uncinate.

There is but one species, viz.:—

Peloscolex variegatus, Leidy.

P. variegatus, Leidy, P. Acad. Nat. Sci. Philadelphia, 1850, p. 124.

Definition. *Length* 4 *lines. Six to ten setae in each dorsal bundle. Two to three in ventral bundle. Hab.—N. America.*

It is quite clear that this worm is a Tubificid. The characters of the setae are not of themselves sufficient to prove this; but the statement that the clitellum occupies the tenth segment, added to the characters of the setae, is not reconcileable with its location in any other known family. Vejdovsky (**24**, p. 45) includes it among the Tubificidae

'incertae sedis.' I regard this genus and species as distinct from *Spirosperma ferox* (with which, on account of the integumental tubercles, it might be confounded), for the reason that there are no setae but capilliform setae in the dorsal bundles. This peculiarity has been stated to occur by GRUBE in his species '*Saenuris velutina*,' to which attention has been duly called by VEJDOVSKY, who considers further evidence desirable before the absence of uncinate setae from the dorsal bundles can be regarded as fully proved. It seems improbable that *both* GRUBE and LEIDY would have fallen into error about a point of this kind, and, furthermore, it seems probable that *S. velutina* is identical with *Embolocephalus velutina* (see below). *Embolocephalus*, however, has only two setae on each bundle; this worm can also retract the prostomium and first segment, so that the body appears to commence with the first setigerous segment. It inhabits the depths of the Lakes of Geneva and Zürich. *P. variegatus* was found by LEIDY in springs, the water of which was impregnated with iron, in the neighbourhood of Philadelphia; there is no mention of any power of retracting the end of the body. I am disposed, therefore, to consider that the genus *Peloscolex* is a valid genus, distinguishable from nearly all other Tubificidae by the presence of capilliform setae only in the dorsal fasciculus.

It may be that *Nais papillosa* should be transferred from *Spirosperma* to the present genus.

Genus **PSAMMORYCTES**, VEJDOVSKY.

Syn. **Saenuris**, KESSLER (in part.).
Tubifex, LANKESTER (in part.).
Archaeoryctes, CZERNIAVSKY.

DEFINITION. **Setae capilliform, uncinate, palmate, and pectinate. Spermiducal glands, with a vesicula seminalis; prostate as in *Tubifex;* spermathecae opening in common with a muscular sac containing a single long seta; appended to this sac are two or four glands.**

The genus *Psammoryctes* has been investigated by LANKESTER (**2**), VEJDOVSKY (**13**, **24**), PERRIER (**7**), and, more recently, by STOLC (**3**); VEJDOVSKY established its distinctness from *Tubifex*, with which it had been confounded by LANKESTER and PERRIER; the differences which this genus shows from *Tubifex* were still further accentuated by STOLC, who described and figured the remarkable apparatus in connexion with the apertures of the spermathecae. These have been already described (see p. 132). I quite agree with VAILLANT in relegating CZERNIAVSKY'S *Archaeoryctes* to this genus. The only difference alleged by CZERNIAVSKY is that

the setae of the dorsal bundles in the anterior segments are partly tridentate instead of pectinate—a difference which VAILLANT justly considers as at most specific.

Three species have been referred to this genus, viz. *P. barbatus*, *P. remifer*, and *P. batillifer*. About the first there is no question; it is, perhaps, doubtful whether *P. remifer* should be placed in this genus. The peculiar setae of some of the anterior segments appear to differ from those of the type-species as well as from those of any other Tubificid. It is obviously desirable that we should have more information about both *P. remifer* and *P. batillifer*, before any definite statement can be made as to their systematic position.

Psammoryctes barbatus (GRUBE).

Saenuris barbata, GRUBE, Ein Ausflug nach Triest und Quarnero, 1861, p. 75.
S. (Naidina) umbellifera, KESSLER, Trud. Russk. Est. St. Petersb., 1868, p. 107.
Tubifex umbellifer, LANKESTER, Ann. and Mag. Nat. Hist., Feb., 1871, p. 93.
Psammoryctes umbellifer, VEJDOVSKY, SB. Böhm. Ges., 1875, p. 194.
P. barbatus, VEJDOVSKY, SB. Böhm. Ges., 1883, p. 224.

Definition. *Length* 40 *mm.; number of segments* 90. *Prostomium as long as buccal segment. Uncinate setae with equal prongs or with one longer than the other, the first kind found from eleventh segment onwards in both dorsal and ventral bundles, the other in ventral bundles of anterior segments; no setae on XI; palmate setae in II—X. Hab.—Europe.*

GRUBE'S description was far too imperfect to admit of a recognition of the species; hence the synonymy. The identity of GRUBE'S species was cleared up by VEJDOVSKY, who examined the type of '*Saenuris barbata*.' This species is amply illustrated in the works of LANKESTER (**10**), VEJDOVSKY (**13**, **24**), STOLC (**3**); see also BENHAM (**9**).

Genus **HEMITUBIFEX**, EISEN.

Syn. **Clitellio**, CLAPARÈDE (in part.).
Tubifex, D'UDEKEM (in part).
Peloryctes, ZENGER.

DEFINITION. Setae of two kinds, capilliform, and uncinate, the former only in dorsal bundles. A special chamber ('vesicula seminalis') constricted off from spermiducal gland above into which prostate opens.

This genus comprises not only the species *H. insignis*, for the reception of which the genus was created by EISEN in 1870, but also, as I have shown (**70**), the marine worm '*Clitellio ater*' of CLAPARÈDE (**3**) (=*T. benedii*, D'UDEKEM). Possibly some

others among the littoral Tubificidae, which have been but little studied, will be found to belong to the same genus. There are no points of special interest in the anatomy of this genus. It comes nearest perhaps to *Tubifex,* from which it differs principally in the dilated extremity of the spermiducal gland, and in the chitinous penis. EISEN placed the genus nearer to *Psammoryctes,* but STOLC's recent investigations upon this worm (**3**) have increased the differences between the two genera, which, however, agree in the division of the spermiducal gland into two chambers, and in the fact that there are glands appended to the spermathecae. It is very possible that both *Ilyodrilus perrieri* and *Ilyodrilus fragilis* should also be referred to the present genus. VAILLANT (p. 395) has already made the suggestion with regard to *Ilyodrilus fragilis.*

I have, however, pointed out (**70**, p. 487) that capilliform setae are sometimes present, and sometimes absent in worms belonging to a species, which must, I think, be CLAPARÈDE'S *C. ater*, and D'UDEKEM'S *Tubifex benedii.* Thus the principal difficulty in the way of regarding these two worms as the same species is removed. *Peloryctes inquilina* of ZENGER is placed by VAILLANT among the synonyms of *C. arenarius*, but *also*, evidently by an oversight, mentioned (on p. 435) as a distinct species of *Clitellio.* It cannot, I think, be distinguished from CLAPARÈDE'S *C. ater.* ZENGER attempts to distinguish it mainly by the number of setae in the bundles (an eminently untrustworthy character except when applied with great caution) by the distribution of the papillae, and the presence of more than one pair of hearts.

(1) Hemitubifex insignis, EISEN.

H. insignis, G. EISEN, Bih. K. Svensk. Akad., 1879, No. 16, p. 13.

Definition. *Length 25 mm.; no integumental papillae. Spermathecae with glands at neck. Hab.—Sweden.*

For a fuller account of the anatomy of this species with illustrations, see EISEN (**12**).

(2) Hemitubifex benedii (D'UDEKEM).

Tubifex benedii, D'UDEKEM, Bull. Acad. Roy. Belg. t. xxii., 2nd pt., 1855, p. 544.
Clitellio ater, CLAPARÈDE, Mém. Soc. Phys. Gen. 1862, p. 253.
T. papillosus, CLAPARÈDE, Beobacht. wirbell. Thiere, 1863, p. 25.
Hemitubifex ater, BEDDARD, P. Z. S. 1888, p. 485.
Clitellio (Clitellio) benedii, VAILLANT, Annelés, p. 418.
? **Nais pustulosa**, WILLIAMS, Phil. Trans., 1858, p. 96.
Peloryctes inquilina, ZENGER, Bull. Soc. Nat. Mosc., 1870, p. 221.

Definition. *Length 55 mm. Integument covered with numerous greyish green papillae, which commence at middle of second segment and are not found upon clitellum. Hab.—Sea shores of Europe.*

The synonymy of the species described as *Clitellio ater* by CLAPARÈDE is very difficult. There can be but little doubt, however, that it is synonymous with D'UDEKEM'S *Tubifex benedii* as was first pointed out by VAILLANT (**3**). I cannot myself see any valid reason for separating it from *T. papillosus* of CLAPARÈDE, in spite of the fact that both species were described by the same writer. CLAPARÈDE, indeed, says that the papillae of *T. papillosus* are flatter than those of *C. ater;* but the principal difference upon which CLAPARÈDE relied was evidently the presence of capilliform setae figured (**4**, Taf. iii, fig. 15) in *T. papillosus*, which he speaks of on this account as 'ein echter Tubifex.'

Genus SPIROSPERMA, EISEN.

Nais, KESSLER (in part.).

Tubifex, CLAPARÈDE, D'UDEKEM (in part.).

DEFINITION. **Body covered with convex papillae. Setae capilliform, uncinate and pectinate. Prostate present; penis chitinous. Brain with median processes in front, prominent lateral lobes, with a square invagination posteriorly.**

The structure of this well-marked genus has been investigated by EISEN (**12**) and STOLC (**3**). The setae are like those of *Psammoryctes*, from which genus it differs in the absence of a specialized division of the spermiducal gland, and in the presence of the epidermal papillae which are evidently like those of *Hemitubifex benedii*. It is even possible that the two genera should be fused into one, the only difference being, apparently, the existence of pectinate setae in *Spirosperma*, which have not been described in *Hemitubifex*. The name *Spirosperma* was given to the genus by EISEN on account of the form of the spermatophore, which is coiled like a watch spring, or, as EISEN says, like the proboscis of a moth (**12**, Pl. iii. fig. 2 *i*, 2 *k*). It appears, however, that the spermatophore has not always this shape, for STOLC figures one (**3**, Taf. iii. fig. 11) in which one half of the spermatophore is coiled spirally round the other half, and another (in fig. 10) which is bent into an S shape. The spermathecae are simple pouches swollen at the caecal extremity. The epidermal papillae are wanting upon the clitellum, which is stated by EISEN to occupy only one segment, the eleventh.

Spirosperma papillosus (KESSLER).

Nais papillosa, KESSLER, Trud. Russk. Est. St. Petersb., 1868, p. 105.
Spirosperma ferox, EISEN, Bih. K. Svensk. Akad., 1879, No. 16, p. 10.

Definition. *Length* 15 *mm. Dorsal setae capilliform and pectinate; ventral setae uncinate, some of them with two or three denticles. Nephridia without vesicular cells, no terminal dilated sac. Hab.—Europe.*

The probable identity of EISEN'S *Spirosperma ferox* with *Nais papillosa* of KESSLER was pointed out by EISEN himself; and VEJDOVSKY (**24**, p. 45) suggested that GRUBE'S '*Saenuris velutina*' may be identical. Both are placed as synonyms by STOLC. Nevertheless, according to GRUBE, *Saenuris velutina* has nothing but capilliform setae in the dorsal bundles, and the clitellum extends from segment ix–xii. Influenced, no doubt, by these differences in the descriptions of the two species, VAILLANT does not unite them, but places GRUBE'S worm in the genus *Tubifex*. BENHAM has described and figured the webbed setae of this species (**9**).

Genus TELMATODRILUS, EISEN.

DEFINITION. Setae all uncinate. Brain concave in front with a narrow process posteriorly. Circumoesophageal blood-vessels of segments VII–XI contractile. Integumental vascular system developed. Spermiducal gland furnished with numerous (8–10) prostates; penis chitinous.

This remarkable genus has been only seen and described by EISEN; it consists of but one species. EISEN places it in a special subfamily, that of the *Telmatodrilini;* but a further splitting up of the Tubificidae seems hardly necessary. The most distinctive peculiarity of the genus is undoubtedly the numerous prostates; but except for this the efferent apparatus shows no difference from that of *Limnodrilus* and *Spirosperma*. The contractility of the anterior perivisceral blood-trunks is shared by the genus *Branchiura*, but in *Telmatodrilus* only one of these pairs of vessels—that of the eleventh segment is larger than the rest. The approximation of the dorsal ventral vessels upon one side of the intestine, is also something like what is found in *Branchiura;* so too the integumental vascular network; in this respect, however, *Ilyodrilus* and, to a less extent, *Limnodrilus*, resemble *Telmatodrilus*. The spermathecae are a pair of simple oval pouches, which open between the dorsal and ventral setae bundles in the tenth segment—an anomalous position for the Tubificidae.

There is at present but one species known, viz. *T. vejdovskii;* but as the external characters are similar to those of *Limnodrilus* and *Clitellio*, it is possible that some of the species doubtfully referred to these genera may belong to *Telmatodrilus.*

Telmatodrilus vejdovskii, Eisen.

T. vejdovskii, Eisen, Bih. K. Svensk. Akad., 1879, No. 16, p. 8.

Definition. *Length* 35–50 *mm. Intestine begins in XI; pigmented peritoneal coating of intestine begins in XV. Nephridia with vesicular peritoneal cells and without dilated end sac. Hab.—California, at an altitude of* 6,000–10,000 *ft.*

The worm is described by Eisen as being torpid in its habits, not active like many Tubificidae; it lies in the mud as does *Tubifex*, &c. with the tail protruding. The setae are eight to fifteen in number in each bundle; in the adult they are sigmoid without terminal bifurcation, which is only apparent in young specimens. No spermatophores were found in the spermathecae.

Genus Ilyodrilus, Eisen.

Definition. **Capilliform setae in dorsal bundles, uncinate setae with a web, penial setae, not very different from ordinary uncinate setae, in neighbourhood of male-pores. An integumental plexus of blood-vessels present. Nephridia with a dilated region after funnel. Spermiducal gland with thick covering of gland-cells; no spermatophores; ova develop as in Naids.**

It seems to me to be not a little doubtful whether this generic name can be retained. The name was applied by Eisen (**12**) to a number of species of Tubificids found in California, which I cannot differentiate from the genera *Tubifex*, and *Hemitubifex*. To this genus (*Ilyodrilus*) Stolc (**3**) referred the species described by Vejdovsky (**11**) as *Tubifex coccineus*, and later (**24**) as *T. rivulorum*, var. *coccineus*. Stolc has given an elaborate account of the structure of '*Ilyodrilus*' *coccineus*, which appears to me to prevent anyone from placing it in the same genus as any of the three species described by Eisen as *Ilyodrilus*. Eisen's *Ilyodrilus* has small separate prostates, which are absent from *I. coccineus;* it has not penial setae which are present in *I. coccineus*, as was first pointed out by Vejdovsky (p. 156, footnote); the only resemblance of importance seems to be that in *I. sodalis* the eggs develop in the same way as in *I. coccineus*, and that in the American worms no spermato-

phores are to be found [1]. VAILLANT eliminates *I. coccineus* from the genus *Ilyodrilus*, restricting the genus to the three American species, remarking (**6**, p. 349) that the former is, according to VEJDOVSKY, merely a variety of *T. rivulorum;* this was certainly VEJDOVSKY'S original opinion when writing his great monograph; but in a footnote to a later page (p. 156) of that monograph, he distinctly refers to *I. coccineus;* by this time, no doubt, STOLC had completed his researches on the worm, proving its distinctness from *Tubifex;* hence the footnote, probably added as the work was passing through the press. Restricting the genus, as I propose to do here, it will contain only one species—*I. coccineus.*

EISEN'S genus *Ilyodrilus* will not, I think, stand; the three species of which it is composed are not, in my opinion, referable to the same genus so long as we allow the numerous genera adopted in the present work; the differential characters of the genus, as given in EISEN'S work upon the Tubificidae, by no means apply to all the species; the only character that does so apply, and is of real importance, is the absence of spermatophores; I should venture, however, to doubt the real absence of the spermatophores, since the three species all of them possess prostates; in all Tubificidae, with the exception of *Telmatodrilus*, which have prostates, there are spermatophores formed. Another character used by EISEN in the generic description is the absence of glands at the base of the spermathecae; there are, however, such in '*Ilyodrilus*' *sodalis;* can this species be put anywhere than in one of the genera *Tubifex* or *Hemitubifex?* The glands at the base of the spermathecae ally it to the latter, from which the absence of a vesicula seminalis distinguishes it. In this it agrees with *Tubifex*, and in having a soft penis without chitinous sheath. As in both genera there are no pectinate setae; in the species under discussion the two prongs of the uncinate setae have fine denticulations along the inner margin, but these setae are hardly comparable to the pectinate setae of other genera. I am disposed to refer this species to the genus *Tubifex*, in spite of the presence of glandular appendages to the spermathecae. '*Ilyodrilus*' *perrieri*, unlike the last species, and unlike *Tubifex*, has a chitinous sheath to the penis; there is a very faintly developed pectination of the uncinate setae; this species seems to come nearest to *Hemitubifex*. '*Ilyodrilus*' *fragilis* is the only remaining species of EISEN'S genus; it must go, I think, with the last into the genus *Hemitubifex* (as VAILLANT has suggested). These three species seem to unite the genera *Tubifex* and *Hemitubifex*. Apart from these species the two genera in question are separated by very slender characters. In *Tubifex* the penis is soft, and there is no vesicula

[1] VEJDOVSKY (**24**, Taf. iv. fig. 13) has figured the spermatophore of *T. coccineus*, but it is to be presumed that this is an error.

seminalis; in *Hemitubifex* the penis is chitinous, and there is a vesicula seminalis. The characters of these two genera, and of the three species of *Ilyodrilus* described by Eisen, will be best shown in a table which follows:—

	SETAE.	VASCULAR SYSTEM.	PENIS.	SPERMATHECAE.	SPERMIDUCAL GLAND.
Ilyodrilus sodalis	uncinate setae with both prongs denticulate; capilliform setae in dorsal bundles	no hearts; last perivisceral in x; all contractile	soft	with bilobed gland at base	no vesicula
Ilyodrilus fragilis	as above	as above (?)	chitinous	no gland	no vesicula
Ilyodrilus perrieri	uncinate setae with web; capilliform setae in dorsal bundles	as above (?)	chitinous	no gland	no vesicula
Hemitubifex ater	capilliform setae in dorsal bundles	?	chitinous	no gland	a vesicula
Hemitubifex insignis	as above	?	chitinous	three glands at base	a vesicula
Tubifex rivulorum	as above	hearts in viii	soft	no glands	no vesicula

ILYODRILUS (STOLC).	ILYODRILUS (EISEN).
Nephridia with 'brown gland.'	Nephridia without that gland.
Spermiducal glands, like that of Lumbriculidae.	Spermiducal glands, as in *Tubifex*.
Penial setae.	No penial setae.
Spermatheca globular and sessile.	Spermatheca with duct.

There may be other points of difference; but in any case it seems to me that the first two are amply sufficient to distinguish the European *Ilyodrilus* from its supposed American congeners.

Ilyodrilus coccineus, Vejdovsky.

Tubifex coccineus, Vejdovsky, SB. Böhm. Ges. 1875, p. 193.

T. rivulorum (in part.), Macintosh, Trans. Roy. Soc. Ed. 1870, p. 253.

T. rivulorum var. coccineus, Vejdovsky, Syst. u. Morph., p. 46.

Ilyodrilus coccineus, Vejdovsky, ibid. p. 150, footnote.

Definition. *Brain with a median process in front, and with two processes in the middle line behind at origin of visceral nerves. Spermathecae globular and sessile; genital setae sometimes without notch. Hab.—Europe.*

The synonymy of this species is a little confused. There seems to be no doubt

that, as STOLC has pointed out, MACINTOSH partially described this species in his paper upon the structure of *Tubifex*. He distinguishes 'two species' of *Tubifex*, the one which he considers to have most claims to be called *Tubifex rivulorum*, being in all probability identical with *Ilyodrilus coccineus;* the reasons for this identification are—(1) the shape of the setae; MACINTOSH found no traces of the 'brush tip' to the uncinate setae of this form such as characterize the true *T. rivulorum;* as he figures the latter kind of setae in the 'elongated form from the lakes' (really the true *T. rivulorum*), it seems clear that no mistake has been made, even if it was reasonable to doubt the accuracy of so experienced a worker; (2) the integumental network is particularly referred to as existing in the shorter form of '*Tubifex*'; (3) the peculiar brown glandular body lying upon the course of the nephridium is figured (Pl. ix. fig. 18) for the form which is to be regarded as the same as STOLC's *I. coccineus*. VEJDOVSKY at first distinguished his *T. coccineus* from *T. rivulorum;* in his work upon the Oligochaeta in general he places (p. 46) *T. coccineus* among the synonyms of *T. rivulorum*, on the grounds that there are numerous transitions between this form and the worm described by various authors as *T. rivulorum;* as, however, '*T. rivulorum*' of some authors is now fairly certainly known to be no less than *I. coccineus*, this argument loses its force. Later (p. 146) in the same work VEJDOVSKY, in dealing with the egg development, which is after the Naid plan, again emphasizes the difference between his *T. coccineus* and the common form, *T. rivulorum:* there seems to be no doubt that RATZEL's description of the egg development in '*T. rivulorum*' referred to the present species, and that there was no dimorphism —as he thought—or pathological conditions—as thought LANKESTER and NASSE. Still later, in a footnote to p. 156, VEJDOVSKY refers to the worm as *I. coccineus* without any explanation of his alteration of opinion, and in the section dealing with the relationships of the Oligochaeta the same author mentions the sexual setae (mentioned also in the place just referred to) as evidence of the relationships of '*Ilyodrilus*' to the Naidomorpha. It is difficult to understand how VAILLANT, with STOLC's paper upon *Ilyodrilus* before him, could have put it as a mere synonym of *T. rivulorum;* his reasons for doing this are because VEJDOVSKY thought so at one time, before the species had been re-investigated by STOLC. It is the more remarkable that VAILLANT should have overlooked the differences between the two species, as *Ilyodrilus* is so thoroughly intermediate between the Naids and the Tubificids, which VAILLANT unites into one single family. To have emphasized its differences from *Tubifex* and resemblances to Naids would have greatly strengthened VAILLANT's position

I take this opportunity of referring to NICHOLSON'S *Saenuris canadensis* (see VERRILL) merely for completeness' sake, as it is unidentifiable.

Genus BOTHRIONEURON, STOLC.

? *Syn.* **Monopylephorus**, LEVINSEN.

DEFINITION. **Setae only uncinate, ventral setae of segment XI sometimes modified. Male pore single or paired. Spermiducal gland with a short diverticulum bearing the prostate. No spermathecae; spermatophores fixed to the integument near to male pore.**

I believe that LEVINSEN'S genus *Monopylephorus* is identical with STOLC'S recently (3) described *Bothrioneuron*. LEVINSEN gives but few details about his genus; he states, however, in the table of the generic characters of the Tubificidae (p. 223) that there are no capilliform setae, that the male pore is unpaired, and that the penis is without a chitinous sheath. In all these characters *Monopylephorus* agrees with *Bothrioneuron*, except perhaps in the presence of a penis; in *Bothrioneuron*, however, STOLC has figured (Tav. iv, fig. 7) a short diverticulum of the spermiducal gland, near to the external aperture of the latter, which may possibly be everted at times and give the appearance of the penis of other Tubificidae. VAILLANT (6) considers not only that *Monopylephorus* is synonymous with *Clitellio*, but that LEVINSEN'S species, *M. rubroniveus*, is identical with *C. arenarius*. It is true that the latter identification is prefaced by a query; but I do not see any reason why VAILLANT should suggest that LEVINSEN'S genus should be considered 'doubtful.'

The most marked characters of this genus are the absence of the spermathecae and the peculiar form of the spermiducal glands; there is no other Tubificid in which spermathecae have not been found. The absence of these organs is correlated by STOLC with the remarkable form of the spermatophores; these have an appearance in STOLC'S figures which recall the corresponding organs in Lumbricidae; they are stalked bodies invariably found attached in the neighbourhood of the male pore. The free end is wider and oval in form, and seems to contain the sperm. The two spermiducal glands open by a common pore, which is in the middle line of the eleventh segment; each is divided into two regions, the two being separated by a constriction; into the distal region opens the short and slender sperm-duct; STOLC considers it to be a dilated part of the sperm-duct rather than a part of the spermiducal gland; it differs from the succeeding section by the thicker coating of peritoneum, the thickening being due not to an increase in the number of cells, but in their greater depth; the lumen, too, is much narrower than in the section of the terminal gland which follows, though the entire width of the tube is about the same; the following section is lined by a higher cylindrical epithelium and is covered by a lower layer of peritoneal cells;

at about the middle point there is a short diverticulum, which VEJDOVSKY terms the 'paratrium,' and on to the summit of which is grafted the prostate; the cells lining the paratrium are larger than those which line the sac, of which it is a diverticulum, though they get to be very small before the opening of the paratrium into the latter; the paratrium has presumably a very thin covering of peritoneal cells; none are shown by STOLC in his figure. The prostate is composed of comparatively few cells. Near to the opening on to the exterior there is a short diverticulum to which muscles are attached; this can possibly be extruded.

(1) Bothrioneuron vejdovskyanum, STOLC.

Bothrioneuron vejdovskyanum, STOLC, Abh. k. Böhm. Ges. 1888, p. 43.
? **Monopylephorus rubroniveus,** LEVINSEN, Vid. Med. 1883, p. 225.
? **Clitellio arenarius** (in part.), VAILLANT, Annelés, p. 415.

Definition. *Body covered with papillae. Penial setae with hooked extremity, below which are two ridges with minute denticulations. Hab.—Denmark; Bohemia.*

LEVINSEN regards as a possible synonym of this species D'UDEKEM'S *Tubifex hyalinus.* I cannot see in D'UDEKEM'S definition of the species any grounds for this assumption. I have elsewhere entered into the much more likely view that it is a synonym of *Clitellio arenarius.*

(2) Bothrioneuron americanum, BEDDARD.

B. americanum, BEDDARD, Ann. & Mag. Nat. Hist. Feb. 1894, p. 206.

Definition. *Length about one inch. Male pores paired. No penial setae. No spermatophores (?) Hab.—Buenos Ayres.*

Genus LOPHOCHAETA, STOLC.

DEFINITION. Dorsal setae plumose and pectinate, ventral setae uncinate. One pair of intestinal hearts in IX, in II–VII slender periviscerals. Penis chitinous.

The most distinguishing character of this genus is in the form of some of the dorsal setae; these are like those of *Tubifex* in being capilliform, but differ in that the seta is beset with fine branches, giving it the appearance of the hairs of many Crustacea; this form of seta is unique among the Oligochaeta, the only approach to it being found in *Bohemilla*, where one side of the seta is furnished with such processes. The structure

of the reproductive organs does not materially differ from that of *Tubifex* or *Limnodrilus;* the spermiducal gland is short and the sperm-duct rather long; at the point where the solid prostate is attached to the former it (the spermiducal gland) is somewhat dilated. There is only one species of the genus.

Lophochaeta ignota, Stolc.

L. ignota, Stolc, Abh. k. Böhm. Ges. 1888, p. 41.

Definition. *Pectinate setae of dorsal bundles, with four prongs and a web. Chitinous penis conical in form. Hab.—Bohemia.*

It is a curious fact about this species that no spermatophores have been found. The spermatheca are pear-shaped pouches, there being no constriction between the pouch and its duct, such as developed in *Limnodrilus.*

Genus BRANCHIURA, Beddard.

Definition. Posterior segments with a series of contractile branchial processes in dorsal and ventral median lines, a pair to each segment. Setae capilliform and uncinate, capilliform setae in dorsal bundles of anterior segments only. Two pairs of enlarged circular vessels (hearts) in IX and X. These and anterior perivisceral loops contractile. Dorsal vessel ventral in position in all segments after the twelfth.

This very remarkable genus of Tubificidae was found by myself in the 'Victoria regia' tank in the Botanical Society's Gardens, Regent's Park, London, and described with illustrations in the Quarterly Journal of Microscopical Science. It agrees with *Hemitubifex* and some other genera in the form of the setae, but differs from all Tubificidae except *Hesperodrilus branchiatus* in possessing branchiae, and from all Oligochaeta in the form of those branchiae. They consist of a series of pairs of cylindrical processes arising from the middle dorsal and ventral lines; each branchia has a capillary loop lying beneath the epidermis and a layer of muscles; the cavity of the branchiae, which is shut off from the general body by a diaphragm, is lined by peritoneum and traversed by muscular strands. The branchiae move actively during life, and can be extended and retracted. The circulatory system, like that of *Ilyodrilus* and some other genera, has in addition to the dorsal and ventral vessels a supraintestinal trunk, and, as in *Ilyodrilus* and *Telmatodrilus*, there is an integumental network of blood-vessels. All the perivisceral trunks of the segments in front of and including the tenth are contractile, those of the ninth and tenth segments being specially enlarged.

Branchiura sowerbii, BEDDARD.

B. sowerbii, BEDDARD, Q. J. M. S. vol. xxxiii (1892), p. 325.

Definition. *Length about* 25 *mm.; number of segments about* 170. *Branchiae upon last* 50–80 *segments. Nephridia commence in segment XII. Hab.—? (Found in Victoria regia tank in Botanical Society's Gardens, Regent's Park, London).*

This worm like most (?all) other Oligochaeta can reproduce its tail; I cut off the entire gill-bearing region of a specimen, and in nine days there were four pairs of gills, *not* on the regenerated tail, which had only one small gill, but on the stump left behind, which was unprovided with gills before amputation.

Genus VERMICULUS, GOODRICH.

DEFINITION. **Setae entirely uncinate. Clitellum X–XIII. Sperm-duct pore, and spermathecal pore single. Sperm-ducts short and wide.**

This is a distinct genus, unless it be really identical with *Monopylephorus;* I believe, however, that that genus is, as I have said, on p. 268, the same as STOLC'S *Bothrioneuron;* in this case *Vermiculus* cannot well be identical with any form known at present. Its most remarkable peculiarity is partially shared with *Monopylephorus;* that is, the single genital orifice. In the present genus, however, there are spermathecae —wanting in the former. Both organs open together by a common median pore. The oviducts are unpaired and open as usual between segments xi/xii. The clitellum is unusually extensive for this family. The spermiducal gland is reduced to a widish cavity evidently formed as an invagination of the exterior of segment xi; into this open the two sperm-ducts, which are very remarkable in being short and wide with glandular walls; they are not in the least coiled.

Vermiculus pilosus, GOODRICH.

V. pilosus, GOODRICH, Zool. Anz., 1892, p. 474.

Definition. *Surface of body clothed with fine hairs. Setae* 3–4 *per bundle. Hearts in X. Hab.—Weymouth. Marine.*

The worm was met with on the sea shore at Weymouth; the locality was below high tide mark, and there were found with it other Tubificids and Enchytraeidae; to the naked eye it is said by its discoverer to be indistinguishable from *Heterochaeta costata.* The coelomic fluid is filled by a quantity of round corpuscles, which render the worm very opaque when examined microscopically.

Genus EMBOLOCEPHALUS, RANDOLPH.

Syn. **Saenuris**, GRUBE (in part.).

DEFINITION. **Setae of dorsal bundles capilliform alone or with uncinate setae also. Anterior segments retractile. Non-retractile sense-organs in rows round the segments. Live in a tube fabricated by themselves. Spermiducal glands as in** *Tubifex*.

This genus was formed by RANDOLPH (**1**) for GRUBE'S *Saenuris velutina* and a new species congeneric with it; the two species thus associated differ from each other in a number of points but agree in the characters given in the above definition; the most remarkable feature of the genus appears to be the complete retractility of the first two or three segments of the body; of less importance are the sense organs which RANDOLPH compares to those of *Slavina;* they also resemble those of *Spirosperma.* The genus is doubtless, as its describer suggests, intermediate between the Tubificidae and the Naidomorpha; *Embolocephalus velutina* has, as have some of the Naidomorpha, only capilliform setae in the dorsal bundles; in the other species, however, the setae are like those of other Tubificids. The most remarkable internal structure of the genus is found only in *E. velutina;* in this worm are a pair of glands associated with the ventral setae of the tenth segment; these glands have a lining of glandular cells, and attached to the outside is a mass exactly like the 'prostate' of other Tubificids: in fact the whole gland exactly resembles the spermiducal gland in most other members of the family. There is no doubt in my mind that it is to be compared to the albumen gland of the Lumbriculidae; and its presence thus cements more closely the union between the families Tubificidae and Lumbriculidae.

(1) Embolocephalus velutinus (GRUBE).

Saenuris velutina, GRUBE, JB. Schles. Ges. vat. Cult., 1878, p. 116.

E. velutina, RANDOLPH, Vierteljahrsch. nat. Ges. Zürich, 1892, p. 147.

Definition. *Length 50 mm.; number of segments 70. Two rings of sense-papillae in each segment, one on a level with setae the other on a level with the septa. Dorsal setae all capilliform, two, three, or four to a bundle; ventral bundle consists of two uncinate setae, not always with well-marked cleft at end. Brain concave in front with two posterior lobes. Clitellum X–XII. In segment X a pair of large glands connected with ventral setae. Hab.—Lakes of Zürich and Geneva.*

GRUBE particularly mentions the absence of uncinate setae in the dorsal bundles of this worm, which is one of its chief peculiarities, and enabled it to be identified later. The worm secretes a thick slimy coating in which a quantity of Bacteria and other foreign bodies exist, and which project here and there as papilliform masses. The anatomy has been carefully worked out, and fully illustrated by RANDOLPH (2).

(2) **Embolocephalus plicatus,** RANDOLPH.

E. plicatus, RANDOLPH, loc. cit. p. 147.

Definition. *Length* 40 *mm.; number of segments* 50. *Two rings of sense papillae on each segment equally far away from septa. Dorsal setae with uncinate setae among them. Clitellum X–XII. Hab.—Lake of Zürich.*

There appears to be in this species no extensile proboscis such as exists in the last; it is not quite clear whether this proboscis is merely the extruded pharynx or buccal cavity, or whether it is a peculiar structure. The layer secreted by the worm is thinner in this species than in the last. There is no albumen gland, and there are uncinate setae in the dorsal bundles; the retractility of the head exists, but the segments are not withdrawn as they are in the last species, but are simply closed up in each other like the rings of a concertina. Figures and a fuller description of the species are to be found in RANDOLPH'S paper upon the anatomy of this and the last species.

Appendix to Tubificidae.

Genus **PHREODRILUS,** BEDDARD.

DEFINITION. Setae of two kinds, the dorsal capilliform, the ventral sigmoid; testes in X, XI, fused to form one pair. Spermiducal gland opening on to XII, sperm-duct much coiled, provided with an appendix of considerable length; spermathecae in XIII, long and coiled.

This genus I place near the Tubificidae for the reasons stated above (p. 227). It contains at present only one species, which is found in subterranean wells in New Zealand. This was described by myself a few years ago. The characters of the setae at once distinguish the genus from any other genus of Tubificidae; the dorsal setae

are certainly capilliform, as in the majority of the genera, but they are really a little different in form from the capilliform setae of other Tubificidae. The ventral setae are quite different from those that occur in other genera; there are two in each bundle, both sigmoid but unnotched at the free extremity; one of the two setae of each bundle is decidedly larger than the other. The clitellum is more extensive than in other Tubificids; it appears to occupy some four segments, commencing with xii or xiii. The alimentary tract is, with the exception of the buccal cavity, ciliated throughout; the intestine begins, though the transition is not very strongly marked, in segment xiii.

The blood system is like that of *Lophochaeta* and some other genera in that there is a supra-intestinal vessel, which communicates with the ventral vessel by a single pair of 'intestinal hearts'; these latter are, however, apparently rather more than merely connexions between the two longitudinal trunks; their characters have been already described elsewhere (p. 78). The testes lie in segments x, xi; as one pair are attached to the posterior wall of the former segment and the second pair to the anterior wall of the latter, an appearance is presented of a single testis on each side of the body perforating the septum; this appears actually to be the case, the germinal tissue being traceable through the septum; the sperm-ducts are a single pair only; they open by their funnels into the eleventh segment; the sperm-duct itself is entirely enclosed in the following segment. The most remarkable fact about the sperm-duct is the presence of a diverticulum, already referred to as arising from it, just within the sac which surrounds the spermiducal gland; the diverticulum is lined by an epithelium which is not ciliated; its structure, in fact, is precisely that of the spermathecae. The gland is unusually long and very greatly coiled; the terminal section appears to be protrusible and passes straight from the external orifice upon the twelfth segment: the greater part of the organ is contained within a sac which is formed by the splitting off of its peritoneal coat; this sac also contains the greater part of the windings of the sperm-duct, and there are abundant bunches of spermatozoa lying loosely within its cavity; the sac, in all probability, performs the function of a sperm-sac, but how the spermatozoa get into and out of it is a little difficult to understand, unless they actually pass through the thin walls of the sac. The lining epithelium is not ciliated, and there is no prostate. There are a pair of ovaries in segment xii, and the oviducts open opposite to them. There are egg-sacs formed by a pushing back of the septum dividing segments xii/xiii.

The single pair of spermathecae lie in the fourteenth segment; they are long pouches dilated at the blind extremity, which in the fully mature worm is filled with sperm; the position of these organs behind the other parts of the reproductive system is not found in any other Tubificid, but is known among the Lumbriculidae. The

following table will show in a graphic form the resemblances to and differences from other Tubificidae shown by *Phreodrilus*.

	MALE PORE.	OVIDUCAL PORE.	SPERMIDUCAL GLAND.	SPERMATHECAE.	CLITELLUM.
Phreodrilus . . .	xii	xii/xiii	without prostate	in xiv	xii–xv
Other Tubificids.	xi	xi/xii	with prostate	in x	x–xii (or xiii)

Phreodrilus subterraneus, BEDDARD.

P. subterraneus, BEDDARD, Trans. Roy. Soc. Ed., 1891, p. 273.

Definition. *Length about* 50 *mm.; body semitransparent. Setae one to each dorsal bundle and two in each ventral. Hab.—New Zealand.*

This, the only species of its genus, has a peculiarly delicate appearance which differentiates it from any worm with which I have been able to compare it; the first specimens which I received from Mr. SMITH were obtained from a well; other examples were afterwards met with in non-subterranean water. I dealt with certain points in the anatomy of the species in a preliminary account (24) which was later followed by a more detailed description.

FAMILY NAIDOMORPHA.

DEFINITION. **Aquatic Oligochaeta of small size. Setae usually in four groups upon each segment, sigmoid, bifurcate, hastiform, and capilliform. Sexual reproduction at fixed intervals, between which asexual reproduction by fission occurs. Sexual organs (only known in a few types) are situated far forward, commencing even in the fifth segment.**

This family of Oligochaeta comprises the following recognizable genera:—

(1) **Chaetogaster,** BAER.
(2) **Amphichaeta,** TAUBER.
(3) **Nais,** O. F. MÜLLER.
(4) **Bohemilla,** VEJDOVSKY.
(5) **Pristina,** EHRENBERG.
(6) **Uncinais,** CZERNIAVSKY.
(7) **Chaetobranchus,** BOURNE.
(8) **Dero,** OKEN.

We have a fair knowledge of all these genera. In nearly all the genera of this family, the dorsal setae are wanting in a variable number (varying for the genus) of the anterior segments. This 'cephalization,' as it has been termed by LANKESTER, is still more marked in *Chaetogaster*, where the ventral setae also of some of the anterior segments are wanting, a condition also seen in *Uncinais*. The setae themselves present a considerable range of variety in form, which is partly illustrated on p. 7 in woodcut, fig. 2 *b*. The two most usual kinds of setae are the capilliform and the uncinate; the former, which are never found except in the dorsal bundles, are thicker at the point of origin, and taper gradually to the free extremity; they are sometimes straight, sometimes slightly curved, and longer or shorter; in *Bohemilla* alone these setae are provided with a row of lateral serrations. The uncinate setae are always found in the ventral bundles, and sometimes in the dorsal also. They are shorter and stouter than the others, sigmoid in shape, with a central swelling, and deeply cleft at the free extremity. These two kinds of setae are connected by transitional types, of which there are two types: (1) longish, straight setae, with a swelling at about the end of the second or third, and faintly bifid at the extremity (e.g. in dorsal bundles of middle segments of *Nais elinguis*); (2) shorter, straight setae, sharp at the extremity, near to which is a swelling (e.g. in dorsal bundles of hinder segments of *Nais elinguis*); (3) straight, but with a bent, sickle-shaped extremity (*Chaetobranchus*). These two latter are termed by BOURNE 'spear-shaped setae.' Besides these, there are the genital setae, which have as yet been only described in a very few forms; they are sigmoid in shape, and not cleft at the extremity. The number of setae in each bundle is usually more than two.

In this group of Oligochaeta alone (with the exception of *Branchiura*, *Hesperodrilus branchiatus*, and possibly of the doubtful *Alma nilotica* of EHRENBERG = *Digitibranchus niloticus*, LEV.) the body-wall is prolonged into branchial processes. These are, however, found in only two genera, *Dero* and *Chaetobranchus*; in the former they consist of a set of processes surrounding the anus, in the latter of delicate outgrowths in which the dorsal setae are imbedded. A more minute description of these organs will be found below.

The nervous system of the Naidomorpha is in advance of that of *Aeolosoma*, and conforms to the type characteristic of the Oligochaeta in general. The cerebral ganglia are free of the epidermis, and lie in the first segment; they are manifestly composed of two halves, each of which is, as a rule, furnished with a lateral lobe. A circumpharyngeal commissure unites these ganglia with the ventral ganglionated chain.

The nephridia of the Naidomorpha often show a peculiarity which has been also

recorded in *Aeolosoma*. The nephridia, instead of being paired, are occasionally only present to the number of *one* in each segment. In *Nais heterochaeta*, for example, this appears to be the invariable condition; moreover, in that species the nephridium occupies the two segments following that in which the funnel lies; hence, as BENHAM (**15**, p. 385) remarks, there is really one nephridium in place of four. Here, however, as in *Phreatothrix*, the external pore is invariably upon the segment immediately following that which carries the funnel. This absence of one of the two nephridia of a segment culminates in *Uncinais littoralis*. In this worm so careful an observer as BOURNE remarks (**5**, p. 351) that he 'was unable, even after repeated examination, to discover any nephridia.'

The nephridia in the Naidomorpha are not present in the anterior segments of the body; the segment in which they do commence varies according to the species, and there is frequently an omission of a segment or segments in the series; as, for instance:—

Bohemilla comata, viii, xi, xvi, xviii, xx, xxi.
Pristina equiseta }
Pristina breviseta } ix, x, &c.
Nais heterochaeta, vii, &c. (with some variation in individuals).
Nais elinguis, viii, &c.

That part of the nephridial tube which follows the funnel, but lies in the following segment, is nearly always covered with a brown glandular investment, also found in some of the Lumbriculidae and Tubificidae; this appears to be absent in *N. lacustris*.

Among the Naidomorpha the vascular system shows various modifications. In some it is more on a level with that of *Aeolosoma;* in others it is distinctly like that of the Tubificidae. In the latter group, which is represented by *N. josinae*, the dorsal and ventral trunks are connected by a perienteric arch in all the segments of the body; in the former group it is only in the anterior segments of the body that this communication occurs directly. This being so, it is possible to divide the Naidomorpha into two groups, of which one is nearer to the higher Oligochaeta. It is a matter of obvious interest to inquire whether the resemblance to the higher Oligochaeta is secondary—whether, in fact, the species which show this particular likeness are above or below the others in the scale. Fortunately, we are in possession of evidence which enables this question to be decided with a great amount of probability. BOURNE has observed that in the buds of *Uncinais littoralis* there are a series of vascular arches, one to each segment; but that on the full-grown worm it is only the head-segments which are thus provided.

The vascular system in the genus *Nais* itself has been principally studied by Stolc and Vejdovsky. It is only in *N. josinae* that the dorsal vessel has a series of lateral arches in *all* the segments of the body; in the other species there are only a few such vessels in the anterior segments. In *N. elinguis,* for example, there are three pairs of lateral vessels; these are quite simple; a fourth is sometimes present; three pairs of lateral vessels also occur in *N. barbata, N. lacustris,* and *Naidium luteum;* in *N. lacustris* these vessels are in segments iv, v, vi; in *Naidium* in the same segments; *Pristina longiseta* has four pairs of equally simplè perienteric vessels in segments v, vi, vii, viii; *Pristina* offers a further degree of complication in that the last pair are dilated.

N. serpentina exhibits another kind of complication, a first step, which is afterwards more fully developed; there are three pairs of trunks as in most other Naids, but the first of these are dichotomously divided; in *Bohemilla* the same thing occurs, but the first pair of vessels is not only once dichotomously divided, but again. In *N. heterochaeta* all of the lateral vessels give off branches which join the successive arches, and often make more than one connexion with the ventral vessel; this will be found more fully described below, under the description of that species; finally, in *N. josinae* the anterior lateral vessels are hardly recognizable, as they form an elaborate network. In *Uncinais littoralis* there are still more pairs of lateral vessels; five pairs in all are figured by Bourne (5) in addition to the terminal bifurcation of the dorsal vessel to join the ventral vessel; of these the first two and the terminal bifurcation anastomose by several branches; these lateral vessels end in the seventh segment. In *Chaetogaster* the dorsal and ventral vessels are only united by one pair of lateral vessels; the communication elsewhere is effected by paired branches from the network upon the intestine.

It has been already mentioned that *N. josinae* has a pair of commissural vessels in every segment of the body; the same state of affairs is met with in the genus *Dero.* The circulatory system of this Annelid had been studied by Perrier, Stolc, and by myself. As compared with the other Naidomorpha, *Dero* is very highly organized in its vascular system; a variable number of the anterior lateral vessels are contractile; I found that six were so in *Dero perrieri*; four (Bousfield) is a more usual number. Stolc has described a network formed by the first few lateral vessels in *Dero* (? *sp.*), similar to that of *N. josinae.*

In both *Nais* and *Dero* the intestine is invested by a close network of capillaries; this network takes its origin from the dorsal vessel, and communicates with the ventral vessel by a series of median unpaired vessels, one to each segment.

The reproductive organs in the Naidomorpha have been examined in a few species

only; but so far as the facts go they show a nearly absolute uniformity. The following are the species in which the sexual forms have been studied:—*Nais elinguis*, *N. lacustris*, *N. serpentina*, *Dero multibranchiata*, and *Dero sp.* In all of these the reproductive organs are very far forward; I do not include *Uncinais littoralis* in the list because there are no data in the account given by BOURNE of the ducts, and it is not certain whether the organs which he describes as testes and ovaries are not the sperm-sacs and ovisacs respectively.

The clitellum in *Dero* occupies segments v, vi, vii[1]. The ventral setae are wanting on the sixth segment which bears the orifices of the sperm-ducts. In the species of the genus *Nais* enumerated above there are special genital setae on the segments named, which replace the ordinary setae. In all the Naidomorpha there is a single pair of spermathecae in segment v; in the same segment lie the testes; the sperm-duct is a short tube which expands into the spermiducal gland; in *N. elinguis* the transition between the sperm-duct and the spermiducal gland is so gradual that both structures appear to be one. The ovaries are in the next segment to that which contains the testes; the ripe ova escape by means of a pair of slits between the sixth and seventh segments. The sperm-sac appears to be unpaired.

The Naidomorpha are characterized by the asexual mode of propagation as well as by the apparently rarer sexual process. This process has been studied by a large number of those observers who have dealt with the species belonging to this family; more particularly to be mentioned in this connection are LEUCKART, MAX SCHULZE, PERRIER, BOURNE, and SEMPER. Not having myself investigated the subject I do not attempt any criticism of these various observers, but content myself with a brief description of how the process takes place in the group according to the paper of BOURNE upon the matter. I have furthermore added a short account of a recent memoir by KALLSTENIUS which deals with the same process in the genus *Amphichaeta*. It is important to notice that the asexual method of reproduction in the Naidomorpha follows a more complex course than in *Aeolosoma*; in the latter it is merely division; in the Naidomorpha there is a growth of fresh segments in the middle of the body of the parent worm. I have elsewhere (below) called attention to an appearance often presented by the earthworm *Pontoscolex*, which seems to be not unsuggestive of a trace of a similar process in the higher Oligochaeta.

Budding in the Naidiform Oligochaeta takes place, according to BOURNE (**5**), in the following way:—

[1] STIEREN says vii–xii for *D. multibranchiata*, but the epidermis showed no modification; this part of the body was swollen (perhaps only by genital products?).

A worm divides at a given spot (probably characteristic for the species)[1]; at this point growth takes place and a number of new segments are formed which are in two series, one on either side of the line of division already referred to. The anterior set consists of an indefinite number of segments and form the tail of the anterior of the *two* worms (produced by division of the original worm). The posterior set consists of a definite (and characteristic) number of segments which will form the head of the second worm.

KALLSTENIUS has described the same process in *Amphichaeta*. The worm which is not budding consists of seven segments. The first step towards asexual multiplication is the production of an eighth segment which comes to be separated from the seventh segment by a budding zone. This eighth segment becomes the fourth of the daughter bud, the three anterior being formed from the budding zone and those behind from the original segment—the eighth of the parent. The two individuals then come apart, leaving a budding zone and an eighth segment upon the parent, which gives rise to further division.

The process may be graphically represented thus:—

6—7—		
6—7—		—8
6—7—x		—4—5
6—7—x	x	— —
6—7—x	1x 2x 3x	— — — — —

In considering the genus *Aeolosoma* I have pointed out the characters of certain species which form a transition to the Naidomorpha. VOELTZKOW has observed in Madagascar a form like *N. lacustris*, which has in the integument numerous colourless oil-drops; these are said to present almost the appearance of a black pigmentation. *Chaetogaster*, too, is said to have colourless oil-drops in the integument, and both these forms so far approach *Aeolosoma*, particularly *A. niveum*.

There is one genus of which I do not give a deliberate description with synonyms, &c., as its systematic position cannot at present be fixed with certainty.

The position of *Vetrovermis hyalinus* is uncertain. It is described by IMHOF as occurring in several lakes in Switzerland. The body is not ciliated, and there are only one pair of setae bundles in each segment. 'The setae are thin, quite straight up to either extremity, where they are easily bent from side to side; at the free extremity they are bifid.' There is a swelling at the end of the first third of the seta. It multiplies by division, and sexual organs were not met with.

[1] Not so, according to BENHAM (9), at least not for *N. barbata* and *N. lacustris*.

The body consists of four segments. The ventral nerve-cord has a large number of ganglionic swellings, not always sharply marked off from each other.

IMHOF regards it as nearly allied to *Ctenodrilus*, but remarks that the nervous system lies freely in the coelom, and is not as in that genus imbedded in the body-wall. It differs, however, from *Ctenodrilus* in having only two series of setae, and in this same character agrees with *Chaetogaster*. I may point out also that the arrangement of the nervous system (more ganglia than apparent segments) seems to agree with that of *Chaetogaster*.

Genus NAIS, O. F. MÜLLER.

Syn. **Opsonais,** GERVAIS.
Slavina, VEJDOVSKY.
Ophidonais, GERVAIS.
Serpentina, OERSTED.
Stylaria, LAMARCK, &c.
Stylinais, GERVAIS.
Nereis, LINNAEUS (in part).

DEFINITION. **Dorsal setae commence in segment VI, capilliform only, or capilliform and uncinate, or straight with bifurcate end. Eyes present.**

I believe that we cannot separate the five 'genera' included in the above list of synonyms. BOURNE allows all of them, with the exception of course of *Opsonais;* VAILLANT, on the other hand, merges *Slavina* in *Nais*, and BOUSFIELD includes *Ophidonais* in *Slavina*. All the various species, which I here include under one generic title, agree in the important fact that the first five segments are cephalized—that the dorsal setae do not commence until the sixth segment. It is true that two other undoubtedly distinct genera, viz. *Dero* and *Ripistes*, show the same character; but the former of these is distinguished by the remarkable branchial apparatus at the tail end of the body, while *Ripistes* shows a more advanced degree of cephalization in that the ventral setae also are missing from segments iv, v. The genus *Slavina* of VEJDOVSKY only differs from *Nais* in two points: in the fact that the dorsal setae of the first bundles are much longer than those which follow, and in the presence of the cutaneous sensory papillae. As regards the first point, it may be mentioned that similar differences occur in the species of the genus *Pristina;* the sensory papillae seem to be wanting in *S. gracilis* of LEIDY, which VEJDOVSKY associates with his genus *Slavina;* in refusing to regard these structures as of generic value I am in accord with STOLC and BOURNE, who blame BOUSFIELD for allowing this character to have led him to associate together *Slavina* and *Ophidonais*. At any rate, if these

papillae can occur in species which differ in other comparatively important ways, they cannot be of such use for the purposes of generic definition as VEJDOVSKY would have it.

As to the identity of *Ophidonais* with *Slavina*, which BOUSFIELD argues, and which STOLC and BOURNE dispute, I think it must be upheld. The only difference between the genera is in the setae; in *Ophidonais* the dorsal setae are all short and straight with a cleft extremity. If the dorsal setae of *Ophidonais* were peculiar to the single species assigned to that genus, this character would be unquestionably of some importance; but, as a matter of fact, the two forms are the two extremes met with in the genus *Nais* as defined here; for *Nais elinguis* is exactly intermediate, having both kinds of setae in the dorsal bundle. Finally, as to *Stylaria:* really the only distinguishing feature of this genus is the long prostomium; this structure has led to its being confounded with *Ripistes* (q. v.), with which it has not much in common. I do not believe that this character is sufficient to distinguish it as a genus distinct from *Nais*. There is also a *Pristina* with a long proboscis that does not otherwise differ from its congeners—an argument from analogy. MINOR has urged differences in the way of asexual reproduction; but as VAILLANT has pointed out, he did not always find a distinction between the 'gemmiparity' of *Stylaria* and the 'scissiparity' of *Nais*.

As thus constituted the genus *Nais* will include the following well-characterized species:—

(1) **Nais barbata,** MÜLLER.
(2) „ **elinguis,** MÜLLER.
(3) „ **lacustris,** LINNÉ.
(4) „ **serpentina,** MÜLLER.
(5) „ **gracilis,** LEIDY.
(6) **Nais appendiculata,** D'UDEKEM.
(7) „ **lurida,** TIMM.
(8) „ **josinae,** VEJDOVSKY.
(9) „ **heterochaeta,** BENHAM.
(10) „ **reckei,** FLOERICKE.

In addition to these there are a number of worms which are very possibly members of this genus, but of which no sufficient descriptions exist. These species may be first considered.

The *Nais fusca* of CARTER (Ann. and Mag. Nat. Hist. (3), ii. p. 20), from its habitat might be supposed to be distinct had it not been shown that these smaller Oligochaeta have often a wide range. Its chief difference from *Nais elinguis* is, as VAILLANT has indicated, the absence of eyes; pending further information it may there be regarded as doubtfully distinct.

A number of other species have been provisionally referred to this genus by VAILLANT; some of these, however, are clearly not referable to the genus, while others are insufficiently characterized to permit of their generic position to be stated with any approach to accuracy. They will be found cited on other pages.

I am inclined to think that FLOERICKE'S genus *Caecaria* will have to be incorporated with *Nais*. He regards it as intermediate between *Stylaria* and *Pristina*. It has no eyes, a long prostomium, and the dorsal setae begin on the sixth segment. In *Caecaria rara* the second, third, and fourth dorsal bundles are much shorter than the others. In *C. silesiaca* only the first bundle is shorter. In *C. brevirostris* all are equal. Pending further information, I leave the species as *incertae sedis*.

N. clavicornis of SARS (Beskrivelser og iagttagelser, &c., Bergen, 1835), is apparently a *Tomopteris*.

N. bipunctata (DELLE CHIAJE), *N. picta* (DUJARDIN), *N. quadricuspidata* (FABRICIUS) are also Polychaeta.

N. carolina (BLANCHARD) is quite unrecognizable.

N. scotica is referred to below.

(1) Nais barbata, O. F. MÜLLER.

? **N. barbata,** O. F. MÜLLER, Verm. terrestr., 1774, vol. i, pt. ii, p. 23.

Opsonais obtusa, GERVAIS, Bull. Ac. Roy. Belg., 1838, p. 17.

N. elinguis, DIEFFENBACH, Anat. u. Syst. Studien, 1885, p. 98 (in part.).

Definition. *Dorsal setae bundles with capilliform setae only, which are of two sizes, four to eight in each bundle. Eyes present.*

The brief diagnosis of this species given by O. F. MÜLLER would not be enough to identify even the genus to which the worm belongs, did he not refer to his account of the bearded Naid (die bärtige Naide) published with a plate in an earlier work (**2**). The drawings referred to indicate a *Nais* or a *Bohemilla*, more probably the former, since the much smaller eyes of the latter genus would perhaps have escaped MÜLLER'S attention. There is, however, nothing in the figure to enable one to determine with certainty the identity of this 'bärtige Naide' with the species subsequently called *Nais barbata* by TAUBER, VEJDOVSKY, and others. The only distinction between the 'bearded Naid' and the 'tongueless Naid' mentioned by MÜLLER is the 'beard' of the former, which is evidently the ventral setae of the four first setigerous segments closely crowded together[1], for MÜLLER says (**2**, p. 81) 'unter dem Kopf erscheint ein Klumpen kurzer Borsten gleich einem Barte,' and is, therefore, not a distinction. Strictly speaking, the name '*barbata*' ought perhaps to be dropped, and replaced by GERVAIS' '*obtusa*,' but as the former name is now so well established, such a change is inadvisable.

This species has been greatly confused with the nearly allied *O. elinguis*. D'UDEKEM distinguished them only by the presence or absence of the glandular ventricle. This, however, is no difference; the structure in question appears to be present in both[2]. TAUBER (p. 73) first indicated the only real difference between the two species

[1] DIEFFENBACH (p. 104) evidently did not so interpret the structure in question when he wrote 'eine Nais barbata . . . mit besonderen kleinen Haaren am Munde, habe ich nie finden können.' VAILLANT'S figure (**6**, Pl. xxii. fig. 14), by exaggerating the tactile hairs of the prostomium, might lead to the inference that these were the 'beard.'

[2] VEJDOVSKY, at least, does not refer to its absence in *O. barbata;* but DIEFFENBACH says it is occasionally absent in his *N. elinguis* (= *O. elinguis* + *O. barbata*).

which concerns the seta, and is mentioned in the diagnosis of the two worms given here. Another difference referred to by TAUBER is that in *O. barbata* the ova are deposited in October and November[1]. As TAUBER pointed out, SEMPER also confused these two species. So, too, DIEFFENBACH (p. 99) who regarded the individuals with bifurcate setae in the dorsal bundles as a variety of *N. elinguis*. The species is figured by MÜLLER, VAILLANT (**6**, Pl. xxii, figs. 14, 15). FLOERICKE has applied the name of *N. greeffi* to a worm which I regard as a variety of the present species; the ventral setae are, as in *N. elinguis*, of equal length throughout the body; whereas in *N. barbata* those upon the first four segments are longer.

(2) Nais elinguis, O. F. MÜLLER.

N. elinguis, O. F. MÜLLER, Verm. terrestr. vol. i, pt. ii, 1774, p. 22.
Opsonais elinguis, GERVAIS, Bull. Ac. Roy. Belg., 1838, p. 17.
N. rivulosa, LEIDY, Journ. Acad. Nat. Sci. Philad., 1850, p. 43.

Definition. *Dorsal seta bundles with capilliform and hastiform setae, one to three in each bundle. Eyes present. Hab.—Europe; N. America.*

I think that LEIDY'S *N. rivulosa* cannot be differentiated from *N. elinguis*. This is also the opinion of VAILLANT (**6**, p. 371) and D'UDEKEM (**5**, p. 20). VAILLANT, however, suggests as a possible difference the greater slenderness of the ventral setae in the American species.

(3) Nais lacustris (LINNAEUS).

Nereis lacustris, LINNAEUS, Syst. Nat., 1767, p. 1085.
Nais proboscidea, O. F. MÜLLER, Verm. terrestr. vol. i, pt. ii, 1774, p. 21.
Stylaria proboscidea, EHRENBERG und HEMPRICH, Symb. Phys., 1831.
Stylaria paludosa, LAMARCK, Hist. An. sans Vert., 1816, iii, p. 224.
Stylinais proboscidea, GERVAIS, Bull. Ac. Roy. Belg., 1838, p. 18.
Stylaria lacustris, JOHNSTON, Cat. Worms, 1865, p. 70.
? **Stylaria phyladelphiana,** CZERNIAVSKY, Bull. Soc. Nat. Mosc., 1880, p. 309.
? **Stylaria fossularis,** LEIDY, P. Acad. Nat. Sci. Philadelphia, 1852, p. 287.
non-**N. lacustris,** DALYELL, Powers of the Creator, ii, 1853, p. 130[2].

Definition. *Length, 15 m.; number of segments, 25. Prostomium much elongated. Dorsal seta bundles with capilliform setae only. Eyes present. Hab.—Europe and America.*

[1] As VEJDOVSKY (24, p. 29) has pointed out, the ova of *O. elinguis*, though usually laid in June, are sometimes deposited in autumn, so that this difference is not absolute.

[2] *Chaetogaster.*

This species is referred by recent systematists (VEJDOVSKY, BOURNE, and others) to a distinct genus. I prefer to follow D'UDEKEM and LEVINSEN in regarding it as congeneric with *N. elinguis*, &c. If any species of this genus is to be removed from the others, it should be *O. josinae*. The only character upon which a generic definition could be based is the long prostomium. Were we acquainted with a considerable number of species showing this character, it might be advisable to give it generic value. In the meantime, as there is only one species certainly known, it seems more consistent to lay stress upon the similarity in the cephalization with other species.

This Annelid is one of the best known. It has been studied by BONNET, TREMBLEY, MÜLLER, GRUITHUISEN, TAUBER (**2**, **3**), VEJDOVSKY (**24**), and others.

There is absolutely nothing in the very imperfect description given by LEIDY of his two species '*Stylaria paludosa*,' and '*Stylaria fossularis*' to enable one to understand on what grounds they are separated from '*Stylaria lacustris*.'

The worm measures 10–15 mm. in length; the prostomium is long and slender: its length is put down by MÜLLER as equal to ten segments of the body. The setae of the dorsal bundles (two or three to each bundle) are long and capilliform; the ventral setae (four to six per bundle) are sigmoid and cleft at the extremity; there is sometimes a median swelling. BOURNE 'occasionally observed specimens in which dorsal setae were present in the one or two most posteriorly placed of the usually cephalized segments.'

The species is illustrated by BLAINVILLE (Pl. xxiv, fig. 3), CUVIER (Pl. xxi, figs. 2, 2a), DALYELL (Pl. xvii, figs. 6, 7), D'UDEKEM (**4**, Pl. iii, figs. 17–21), VEJDOVSKY (**24**, Pl. iii, fig. 27, Pl. iv, figs. 1–24, 26–31).

(4) Nais serpentina, O. F. MÜLLER.

N. serpentina, O. F. MÜLLER, Verm. terrestr., vol. i, pt. ii, 1774, p. 20.
Ophidonais serpentina, GERVAIS, Bull. Ac. Roy. Belg. 1838, p. 19.
Serpentina quadristriata, OERSTED, Nat. Tidsskr. 1842, p. 134.
? **Ophidonais vermicularis,** GERVAIS, Bull. Ac. Roy. Belg. 1838, p. 19.
Slavina serpentina, BOUSFIELD, J. Linn. Soc. 1886, p. 268.

Definition. *Dorsal setae short, straight, and bifurcate. Ventral setae of first four bundles with a median thickening; on setae of posterior segments the swelling nearer the fixed end. Three or four pigmented bands on segments II–V. Hab.—Europe.*

This species, described by RÖSEL and O. F. MÜLLER (**2**) (by the latter under the name of 'Die geschlängelte Naide') in the last century, has been chiefly studied by

LANKESTER and VEJDOVSKY. It is the largest of European Naids, measuring, according to the last-named observer, 1·5 to 2 centimetres in length. A chain of four Zooids measures as much as 3 cm.

An illustration showing the natural size of the worm is given by O. F. MÜLLER (**2**, Tab. iv, fig. 1). In a magnified representation (**2**, Tab. iv, fig. 2) the characteristic transverse bands of pigment, which led to OERSTED'S specific name of '*quadristriata*' are shown. A drawing by D'UDEKEM, reproduced by VAILLANT in the third volume of the 'Histoire des Annelés' (Pl. xxiii, fig. 12), shows the same feature, also recognizable in the first published illustration of the worm—that by RÖSEL. *Ophidonais serpentina* is not only larger, but more opaque than other Naids, and is, therefore, less easily studied. It is, therefore, doubtful whether WILLIAMS (**1**) really investigated this species, since he speaks of 'the softness and transparence of the integuments.'

The pharynx occupies the first four segments, being somewhat constricted in the middle and dilated at the two extremities. The oesophagus has no glandular swelling but passes (in the ninth segment) into the intestine; the intestine as well as the last three segments of the oesophagus, are covered with brown peritoneal cells. The dorsal blood-vessel communicates with the ventral by three pairs of vascular arches as well as at the anterior extremity, where it divides into two branches which reunite to form the ventral vessel. The two last pairs of arches, belonging to segments iii and iv, are quite simple; the first pair branch dichotomously, the branches join either one of the two halves of the dorsal vessel or the single ventral trunk. This branching is evidently a simplification of the conditions which occur in *N. josinae* (p. 288). This species has been found with fully developed sexual organs in June (LANKESTER), September, and October (VEJDOVSKY).

GERVAIS (pp. 19, 20) describes both *O. vermicularis*[1], and *O. serpentina*, but declares that it is impossible 'bien caractériser deux espèces de ces animaux'; above GERVAIS remarks upon having taken 'plusieurs fois des *Nais vermicularis* ou *serpentina*, à Paris.' I presume, therefore, that I am right in adding *O. vermicularis* to the list of synonyms.

The species is figured by MÜLLER, BRUGUIÈRE (Pl. liii, figs. 1–4 [after MÜLLER]), VEJDOVSKY (**24**, Pl. iii, figs. 14–16), VAILLANT (**6**, Pl. xxiii, fig. 12), OERSTED (**3**, Pl. iii, fig. 3), and BOUSFIELD (**1**, Pl. xxxiii, fig. 5).

(5) **Nais gracilis,** LEIDY.

N. gracilis, LEIDY, Journ. Acad. Nat. Sci. Philad. 1850, p. 43.

Slavina gracilis, VEJDOVSKY, Syst. u. Morph. 1884, p. 30.

Definition. *Length,* 10 *mm.; number of segments,* 50; *dorsal setae capilliform only; those of*

[1] '*Nais vermicularis auctorum*,' GERVAIS.

segment VI longer than the rest; dorsal bundles of this segment contain three setae each; in the following segments only one dorsal seta on each side. No glandular ventricle. Eyes present. Hab.—Neighbourhood of Philadelphia.

This species evidently belongs, by virtue of the specially elongated setae of the sixth segment, to VEJDOVSKY'S genus *Slavina*, which, as it appears to me, VAILLANT was right in joining with '*Nais*' (=*Opsonais*). *N. gracilis*, however, is probably not identical with *N. appendiculata*, for LEIDY makes no mention of the sensory papillae which, if present, would hardly have escaped his attention. Furthermore, it seems to differ in the limitation of the number of the dorsal setae, and in the absence of a glandular ventricle.

(6) Nais appendiculata, D'UDEKEM.

N. appendiculata, D'UDEKEM, Bull. Acad. Roy. Belg. t. xxii, pt. ii. 1855, p. 552.
Slavina appendiculata, VEJDOVSKY, SB. Böhm. Ges. 1883, p. 219.
? **N. escherosa,** GRUITHUISEN, Nova Act. Ac. Nat. cur. 1828, p. 409.

Definition. *Dorsal setae capilliform only, those of sixth segment very much longer than those of other segments. A row of sensory papillae upon all the segments of the body. Hab.—Europe.*

There can be no doubt that *Slavina appendiculata* of VEJDOVSKY is the same species as *N. appendiculata* of D'UDEKEM. The characteristic sensory papillae are referred to by D'UDEKEM as 'appendices couverts de spicules,' and figured (fig. 3 of his Plate illustrating Memoir). It has been also thought to be identical with the *N. lurida* of TIMM, with which, however, it cannot be confounded.

The worm is figured, in addition to the above quoted authorities by VEJDOVSKY (**24**, Pl. iii, fig. 17–26), BOUSFIELD **1** (Pl. xxxiii, figs. 2, 3, 4, copies from VEJDOVSKY and D'UDEKEM).

(7) Nais lurida, TIMM.

N. lurida, TIMM, Arb. Zool. Zoot. Würzb. 1883, p. 153.
Slavina lurida, BOUSFIELD, J. Linn. Soc. 1886, p. 268.

Definition. *Number of segments, 40; first pair of dorsal setae very long; not more than two in each bundle. Two rows of integumental sense bodies on each segment. Hab.—Europe.*

BOUSFIELD has re-examined this species, and shown it to be quite distinct from

N. appendiculata, with which it has been confounded by VAILLANT. A ventral view of the anterior segments is given by BOUSFIELD.

(8) Nais josinae, VEJDOVSKY.

N. josinae, VEJDOVSKY, SB. Böhm. Ges. 1883, p. 218.

Definition. *Length*, 8 *mm. Dorsal setae bundles, consisting of both capilliform and uncinate setae; ventral setae uncinate only. In anterior segments the dorsal vessel forms a network. Eyes absent. Hab.—Teufelsee, Bohemia.*

This species has been carefully studied by VEJDOVSKY (**24**); it is impossible to say whether it is or is not identical with *N. fusca* of CARTER and *N. scotica* of JOHNSTON. The worm is described by VEJDOVSKY as resembling a *Tubifex* on account of its size (6-8 mm. in length, 15 mm. when dividing). The setae at once distinguish it from *O. elinguis*, for the bifurcate setae of the dorsal bundles are sigmoid, and not straight as in that species. The dorsal vessel anteriorly becomes reduced in calibre; it gives off, in the first five segments, five or six pairs of lateral branches, which form an irregular network; in the posterior segments pairs of lateral trunks (one pair to each segment) with the dorsal and ventral trunks. In segments vii, viii, and ix, these vessels are shorter and stouter, and form veritable hearts, comparable to those of the higher Oligochaeta. The organization of the vascular system of this species places it on a higher level than the other members of the genus to which it may be (in my opinion only temporarily) referred. A more complete knowledge of its structure may very possibly necessitate the creation of a new genus for its reception.

(9) Nais heterochaeta, BENHAM.

N. heterochaeta, BENHAM, Q. J. M. S. vol. xxxiv, 1893, p. 383.

Definition. *Length*, 6 *mm.; number of segments*, 41. *Dorsal bundles consisting of one capilliform and one uncinate seta. Eyes present. Vascular trunks uniting dorsal with the ventral vessels of anterior segments connected successively. Hab.—England.*

This species has a remarkable vascular system, of which the following is a more detailed description. The dorsal vessel divides, as usual, in the prostomium into two lateral trunks, which unite in the fifth segment. The branches running from the dorsal to the lateral trunks in the second segment divide, each of them, into two with a separate union with the laterals. The corresponding circumoesophageal vessels of the next segment give off a branch which joins the perioesophageal of the fourth segment.

The latter give off a similar branch which, before uniting with the perioesophageal of the fifth segment, is connected twice with the lateral vessel of its side. The perioesophageal vessel of the fifth segment gives off a branch which joins that of the sixth; the latter bifurcates, and has two separate unions with the ventral vessel. This is an approach to the irregular network of *N. josinae*. There are slight variations in the setae, sometimes two uncinate or no capilliform in the dorsal bundles, but the above is the normal arrangement. The pigmented covering of the intestine begins in the sixth segment.

(10) **Nais reckei**, FLOERICKE.

Ophidonais reckei, FLOERICKE, Zool. Anz. 1892, p. 469.

Definition. *Dorsal setae short, straight, and pointed. Other characters as in* N. serpentina.
Hab.—Germany.

The setae of this species are unlike those of any other Naid. They are straight and cylindrical, and suddenly end in a fine point.

Genus **PRISTINA**, EHRENBERG.

Syn. **Pristina,** EHRENBERG.
Pristinais, GERVAIS.
Nais, D'UDEKEM (in part.).
Stylaria, TAUBER (in part.).
Naidium, SCHMIDT.

DEFINITION. Dorsal setae commence in the second segment, capillary only or capillary and hastiform, the latter bifurcate or not bifurcate at extremity. Eyes absent. Glandular ventricle present. Septal glands well developed.

I venture to differ from all recent authorities, in combining the two genera *Pristina* and *Naidium*. This step appears to me to be rendered necessary by BOURNE'S (**5**) description of two species which nearly entirely bridge over the gap which formerly separated the two genera. Previous to the publication of that paper the two genera might be thus distinguished.

PRISTINA.	NAIDIUM.
(1) Dorsal setae of segment iii very long.	(1) These setae not longer than the others.
(2) No bifid hastiform setae in dorsal bundles.	(2) Such setae present in dorsal bundles.
(3) Prostomium elongate.	(3) Prostomium short.

The two new species of BOURNE—*Pristina equiseta* and *P. breviseta*—do away with the first and second differential characters. In view of the identity in the cephalization of the two genera, the remaining points of difference are, perhaps, hardly of sufficient importance to warrant generic separation, particularly as only one species of *Naidium* is known, and its range of specific variation, therefore, not ascertained. In both *Naidium* and *Pristina* the restriction of the pharynx to two segments, and the great development of the septal glands are especially remarked upon by VEJDOVSKY, and constitute a bond of union, which may be considered to counterbalance the differences mentioned above.

The well-marked species belonging to this genus are only five, viz.: —

(1) **Pristina longiseta**, EHRENB., Europe and N. America.
(2) „ **equiseta**, BOURNE, England.
(3) „ **breviseta**, BOURNE, Madras.
(4) „ **lutea**, O. SCHM., Europe.
(5) „ **proboscidea**, F. E. B., S. America.

One or two doubtful forms have also been described too incompletely for satisfactory recognition[1]

Pristina inaequalis of EHRENBERG has been thus defined by him:—

'Setis quaternis inaequalibus, una longissima, reliquis brevissimis, pari secundo non diverso, uncinis, subquinis subulatis.'

Pristina breviceps (=*Naidium breviceps*, O. SCHMIDT) is thought by VEJDOVSKY to be an Enchytraeid.

Nais ternaria of SCHMARDA is doubtfully transferred by VAILLANT (6, p. 357) to *Naidium*. The chief reasons for believing it to be a member of the genus *Pristina* are the absence of eyes, and the commencement of both dorsal and ventral setae upon the same segment. The dorsal setae are capillary only. The intestine is said to have a spiral arrangement. The worm occurs in Louisiana, Central America, Cuba, and Jamaica.

(1) Pristina longiseta, EHRENBERG.

P. longiseta, EHRENBERG, Symb. Phys. 1828.

Pristinais longiseta, GERVAIS, Bull. Ac. Roy. Belg. 1838, p. 17.

Nais longiseta, D'UDEKEM, Bull. Ac. Roy. Belg. t. xxii, pt. ii. 1855, p. 552.

Stylaria longiseta, TAUBER, Ann. Dan. 1879, p. 73.

Definition. *Length*, 8 *mm.; number of segments*, 20. *Dorsal setae of segment III much longer than the other. Prostomium long. Glandular ventricle in segment VIII. Five vascular arches connecting dorsal and ventral trunks. Nephridia commence in X. Hab.—Europe.*

[1] It is possible that '*Lumbricus hirsutus*' of DALYELL (p. 140) is referable to this genus.

This is a small species, not measuring more than 8 mm., or 2 mm. according to LEIDY. VAILLANT has thrown some doubt upon the identity of the American and European forms on account of this difference in size.

It may also be pointed out that VEJDOVSKY's figure of this species (**24**, Taf. ii, fig. 13) indicates no abrupt demarcation between the buccal segment and the comparatively short prostomium; in the text (**24**, p. 31) it is remarked 'Der Kopflappen verjüngt sich allmälig zu einem konischen, fadenförmigen Rüssel.' This 'gradual' narrowing is not shown in LEIDY'S figure, nor in D'UDEKEM'S; and in a single example (English, but ? exact locality) examined by myself, the prostomium was as illustrated by LEIDY and D'UDEKEM, *not* VEJDOVSKY. The specimen examined by me being about 4–5 mm. in length connects the two extremes of 2 mm. and 8 mm. As VEJDOVSKY leaves out LEIDY'S *Pristina longiseta* in the list of synonyms given under the species, and does not mention N. America as a locality for the species, but is acquainted with LEIDY'S paper[1], I am disposed to infer that VEJDOVSKY is not certain about the identity of his and LEIDY'S varieties. The question must, I think, be left open for the present.

The prostomium appeared to me to be grooved upon the lower surface, this groove opening into the mouth. The number of segments is 17–20. The dorsal setae are entirely capilliform, two or three are found in each bundle[2]; those of the third segment are, according to VEJDOVSKY's figure, about three times the length of those of other segments. The ventral setae are sigmoid and cleft at the extremity; there are seven or eight to a bundle. The peculiarities of the alimentary canal have been referred to under the genus. The dorsal vessel is connected with the ventral by four pairs of vascular arches in segments iv–vii (VEJDOVSKY, **21**, p. 113), of which the last pair is stouter than the rest. These vessels are entirely unbranched and arise from the dorsal vessel just behind the dissepiment. The nephridia commence in the tenth segment. The perivisceral corpuscles have black, brown, or green contents.

VOELTZKOW has recorded from Madagascar a species very like *P. longiseta*, but no special description is given.

(2) **Pristina equiseta**, BOURNE.

P. equiseta, BOURNE, Q. J. M. S., vol. xxxii (1891), p. 352.

Definition. *Length*, 8 *mm.; number of segments*, 21. *Setae of segment III not elongated; prostomium long. Glandular ventricle in segment VIII. One vascular arch. Nephridia commence in IX. Hab.—England (?).*

This species was discovered by BOURNE in the 'Victoria regia' tank, in the Gardens of the Royal Botanical Society, in Regent's Park, London, whence I had myself

[1] It is not only quoted in list of literature, but the species is referred to in the history of the group, p. 23.

[2] Three to *six* are figured by VEJDOVSKY, three by LEIDY and D'UDEKEM.

obtained specimens. It may not, therefore, be a native of this country. It measures 8 mm. in length and consists of 18–21 segments. The most prominent difference from the last species is the absence of specially elongated setae from the dorsal bundles of segment iii. This is shown in an illustration (Zincograph) facing p. 337 of the memoir. The ventral setae of the fourth segment were often larger and stouter than the rest; it is suggested that these may be genital setae, though no other indications of sexual maturity were met with. The segment in which the single pair of commissural vessels lie is not mentioned. The coelomic corpuscles are large and greenish; sometimes quite black owing to quantity of secreted particles. On account apparently of these the worms look of a chalk-white colour when seen with the naked eye or a lens.

(3) Pristina breviseta, Bourne.

P. breviseta, Bourne, loc. cit. p. 353.

Definition. *Dorsal setae of two kinds, capilliform and hastiform, the latter cleft at extremity. Capilliform setae of segments II and III shorter than following. Nephridia commence in IX. Hab.—Madras.*

This *Pristina* is larger than the other species, and consists of about forty-six segments. It differs from all the species of the genus except *P. lutea* in having bifurcate setae in the dorsal bundles. The shape of these, however, is a little different in the two species. The coelomic corpuscles 'are black and very noticeable.' It has been mentioned above that this genus is characterized by having only one cephalized segment, as in the vast majority of Oligochaeta. This condition, however, appears, so far as the present genus is concerned, to be secondary. Both in this species and in the last Bourne has found that the newly budded head consists of seven segments.

(4) Pristina lutea (O. Schmidt).

Naidium luteum, O. Schmidt, Froriep's Notizen, iii. 1847, p. 322.
? **Nais caecilia**, Mayer, SB. Niederrh. Ges., 1859, p. 45.

Definition. *Length, 15 mm.; number of segments, 30. Dorsal setae, capillary and hastiform. Hearts in V–VII. Glandular ventricle in VIII. Hab.—Elbe.*

I have already indicated (p. 289) the reasons which appear to me to render necessary the inclusion of this species in the genus *Pristina*. Our knowledge of its structure is chiefly due to Vejdovsky (**24**), who has illustrated his description.

(5) **Pristina proboscidea,** new species.

Definition. *Dorsal setae capillary. Prostomium very large as in N. lacustris. Hab.—S. America.*

On a casual glance this would be undoubtedly referred to the species *N. lacustris.* As BOURNE has found in *N. lacustris* dorsal setae occasionally present on some of the segments normally devoid of them, the present worm may be an extreme variation.

Genus **RIPISTES,** DUJARDIN.

Pterostylarides, CZERNIAVSKY.
Stylaria, O. SCHMIDT (in part.).
Nais, GREBNITZKY (in part.).

DEFINITION. **Prostomium elongated. Dorsal setae commence in the sixth segment, the first three pairs of bundles containing setae of great length; ventral setae commence in the second segment, but are absent from IV and V. Eyes present.**

Though neither VEJDOVSKY (**24**), nor VAILLANT (**6**) accept this genus, I think that BOURNE (**5**) is quite right in emphasizing its distinctness from *Stylaria.* But in using CZERNIAVSKY'S name *Pterostylarides,* the name *Ripistes* of DUJARDIN, which clearly has the priority, was overlooked (as VAILLANT, **6**, p. 366, has pointed out). CZERNIAVSKY'S definition does not include a reference to what is really the most important character of the genus, viz. the absence of *both* dorsal and ventral setae from segments iv and v. But the description of the three pairs of extremely long dorsal setae leaves no room for doubt as to the identity of *Pterostylarides* and *Ripistes.* The characters of the cerebral ganglia strengthen the arguments for regarding '*Stylaria parasitica*' of O. SCHMIDT as the type of a genus distinct from *Stylaria.* It is, according to VEJDOVSKY'S figure (**24**, Pl. ii, fig. 10), very short—not prolonged backwards, as is the case with *Nais.* There are two species, viz. *R. parasitica* and *R. macrochaeta.*

(1) **Ripistes parasitica** (O. SCHMIDT).

Ripistes sp., DUJARDIN, Proc.-Verb. Soc. Philom. Paris, 1842, p. 93.
Stylaria parasitica, O. SCHMIDT, Froriep's Notizen, iii, 1847, p. 321.
Nais parasitica, GREBNITZKY, Zapiski novoross. Obstch. Est., 1873, p. 268.
Pterostylarides parasitica, CZERNIAVSKY, Bull. Soc. Nat. Mosc., 1880, p. 310.

Definition. *Length, 6 mm.; number of segments, 20; prostomium about as long as peristomial*

segment. Ventral setae of segments II and III about one-third longer than setae of other segments. Five or six setae in the anterior bundles, seven or eight in the others. Twelve to fifteen setae in three anterior dorsal bundles, all very long. Hab.—Europe.

This species has been chiefly studied by VEJDOVSKY (**24**, Pl. ii, figs. 8–12).

(2) Ripistes macrochaeta (BOURNE).

Pterostylarides macrochaeta, BOURNE, Q. J. M. S., vol. xxxii, p. 349.

Definition. *Prostomium much longer than peristomial segment. Ventral setae bundles of segments II and III consist of two or three setae, those of other segments of two to five setae. Three anterior dorsal seta bundles contain each two to five very long setae, the rest being shorter than the other dorsal setae. Hab.—England.*

This species was described, with an illustration, by BOURNE, in 1891. The description is limited to the external characters which alone are indicated in the figure. A note appended to the description of the species by 'E. R. L.' states that 'the long setae are frequently found thrown forward so as to partly encase and protect the head when the worm forms for itself a temporary tube. They are also used to strike the water in swimming.'

Genus UNCINAIS, LEVINSEN.

Syn. **Paranais,** CZERNIAVSKY.
Nais, AUCT.
Clitellio, VAILLANT (in part.).
Ophidonais, VEJDOVSKY (in part.).
Enchytraeus, MINOR (in part.).

DEFINITION. **Setae entirely uncinate; dorsal setae commence in segment V. On segment V of sexually mature individuals genital setae replace the ordinary ventral setae. Glandular ventricle present. No nephridia (?). Testes (one pair) in VIII and IX. Ovaries in X. Spermathecae in V. Eyes absent.**

The only well-known species of this genus is *U. littoralis;* under this heading the synonymy of the species and genus will be discussed.

The above generic definition is entirely compiled from BOURNE'S (**5**) notes upon *U. littoralis*, which establish its generic rank. BOURNE figures a budding worm and also the reproductive organs and setae of the sexually-mature worm. The most remarkable external characters of the genus are the existence of uncinate setae only, in both dorsal and ventral setae, and the absence of the dorsal setae from all segments

anterior to the fifth. These points distinguish it from all other genera of Naidomorpha. The vascular system consists of a dorsal and ventral vessel which run to the end of the body. In segments ii–iv they are joined by three pairs of circular vessels, which are branched, and, according to BOURNE'S figure (**5**, fig. 2), form a network comparable to that of *N. josinae*, or perhaps more like that of *N. heterochaeta*; but there is no irregularity in the origin of the circular vessels, and there are fewer pairs of them. In segments v–vii the dorsal and ventral trunks communicate by means of unbranched circular vessels. BOURNE records the interesting fact that in the young buds commissural vessels occur in *all* the segments.

The absence of nephridia is, if confirmed, a very remarkable character. Behind the pharynx occur a pair of glands which probably represent the pharyngeal glands of *Nais* and other genera.

The arrangement of the sexual organs differs from that found in *Nais* and in *Clitellio*, to which genus the worm has been referred by VAILLANT. They indicate, however, a transition between the more typical Naids and the Tubificidae.

As in the Naids the paired spermathecae lie in segment v, opening in front of the genital setae which replace the ventral setae of this segment; the pouches are oval in form and restricted to the fifth segment. The genital setae are 'very stout, and longer than the ordinary setae, and they possess a mere rudiment of the crotchet at the free extremity.' The testes and ovaries lie further back than in other Naids, but a segment in front of the position which they occupy in the Tubificidae. The testes[1], of which there are only a single pair, occupy nearly the whole of segments viii and ix; each testis is continuous through the septum which separates these segments—a condition which seems to be paralleled only in the case of the genus *Phreodrilus*. The ovaries lie in the following segment—the tenth. Neither oviducts nor sperm-ducts are mentioned or figured.

(1) **Uncinais littoralis** (O. F. MÜLLER).

Nais littoralis, O. F. MÜLLER, Zool. Dan. 1788, ii, p. 54.

Paranais littoralis, CZERNIAVSKY, Bull. Soc. Nat. Mosc., 1880, p. 311.

Uncinais littoralis, LEVINSEN, Vid. Med. 1883, p. 218.

Clitellio (Clitellio) arenarius, VAILLANT, Annelés, p. 415.

Definition. *Prostomium blunt and rounded. Setae of segments II, III, IV longer and thinner than those which follow. Ventral setae of most segments thicker and shorter than dorsal setae. Hab.—Europe.*

[1] Possibly the structures called 'testes' and 'ovaries' by BOURNE are sperm-sacs and egg-sacs.

The synonymy of this species is a matter of great difficulty. It has been confounded with *Clitellio arenarius* by VAILLANT. Having myself investigated *Clitellio arenarius* of CLAPARÈDE (3), I can state positively that it is not identical with *Paranais littoralis* of BOURNE. ZENGER'S *Peloryctes inquilina* being probably synonymous with *Hemitubifex benedii*, must also be removed from VAILLANT'S list. As D'UDEKEM would hardly have overlooked a cephalization in his '*Tubifex hyalinus*,' if it existed, it is probably safe to remove this species also from the list; it is indeed queried by VAILLANT. Another synonym queried by VAILLANT is *Monopylephorus rubroniveus* of LEVINSEN; I am disposed to regard this as congeneric with *Bothrioneuron* of STOLC. As there is nothing in CZERNIAVSKY'S definition of the genus *Paranais*, or of the species *P. littoralis* to warrant its identity with the species described by BOURNE under the name of *Paranais littoralis*, I venture to use the generic name *Uncinais* of LEVINSEN, the definition of which does fit in. The following are the definitions referred to.

CZERNIAVSKY.

'Setarum fasciculi utrimque bi-seriati, omnes et superiores et inferiores setis uncinatis formati. Corpus lineare teres, postice subtruncatum. Ocelli duo vel nulli.'

LEVINSEN.

'Alle Børsterne Krogbørster . . . Rygbørster mangle i de første 3 børstebærende Ringe; kun første Rings Børster tydelig længere end de øvrige 5-6 i hvert Bundt, senere 3-4; øverste Børstegren noget smallere end nederste.'

(2) Uncinais uncinata (OERSTED).

Nais uncinata, OERSTED, Nat. Tidsskr. 1842, p. 136.

Enchytraeus triventralo-pectinatus, MINOR, Am. Journ. Sci. Arts, XXXV, 1863, p. 35.

Paranais uncinata, CZERNIAVSKY, Bull. Soc. Nat. Mosc., 1880, p. 311.

Ophidonais uncinata, VEJDOVSKY, Syst. u. Morph., 1884, p. 24.

Uncinais uncinata, LEVINSEN, Vid. Med., 1884, p. 218.

Definition. *Length,* 11 *mm.; number of segments,* 20–25. *Setae four in each bundle, always of the same size. Hab.—Europe; America.*

Genus BOHEMILLA, VEJDOVSKY.

Syn. **Nais,** TIMM.

DEFINITION. Dorsal setae begin on segment V; the longer dorsal setae serrated. Eyes present.

This genus, instituted by VEJDOVSKY, seems to be a perfectly good one. It only contains one species, viz.

Bohemilla comata, VEJDOVSKY.

B. comata, VEJDOVSKY, SB. Böhm. Ges. 1883, p. 218.

Nais hamata, TIMM, Arb. Zool. Zoot. Würzb., 1883, p. 152.

Definition *Length 6mm.; number of segments 38. First pair of ventral setae bundles larger than those in two following segments; those of IV very small, sometimes absent. Hab. —Europe.*

This species has been chiefly investigated by VEJDOVSKY.

Genus DERO, OKEN.

Syn. **Proto,** OERSTED.
Uronais, GERVAIS.
Xantho, DUTROCHET.
Aulophorus, SCHMARDA.
Nais, O. F. MÜLLER (in part.).

DEFINITION. **Dorsal setae capilliform and hastiform, commencing upon the sixth segment. Branchial processes present at hinder end of body. Eyes absent. Inhabit tubes**

The principal character of this genus is, of course, afforded by the branchial processes at the end of the body, which are dorsal in position. These are ciliated processes of the integument containing blood-vessels; they really spring from the expanded and funnel-shaped termination of the anus, and there are rarely more than four of them (only in *D. multibranchiata*). Sometimes the occurrence of six or even eight branchial processes has been asserted. In such cases it is the margin of the funnel-shaped expansion, which is drawn out into processes; a pair of these are extraordinarily long in *Dero furcata*. The members of this genus usually (? always) inhabit tubes, which are formed by a viscid secretion from the worm's body to which small extraneous particles adhere. A species investigated by myself (**25**), of whose identity I am not certain, was invariably found in the interior of the stems of dead and decayed aquatic plants. *D. vaga* walks abcut with its tube like a Caddis worm. The genus is also to be characterized by the complete absence of floating perivisceral corpuscles (except in *D. vaga*), which are so distinctive a feature of many Naids. Other points in its structure have been already dealt with. The genus *Dero* is widely distributed like many, if not all, of the aquatic Oligochaeta. It occurs in Europe, North America, the Philippines, Ceylon (if *Aulophorus oxycephala* of SCHMARDA be really a *Dero*), and finally, I have received specimens from Mombasa in East tropical Africa.

The distinction of species is a matter of some difficulty. VAILLANT allows as many as nine; BOUSFIELD only seven, but this number must be increased by two, for BOUSFIELD was not acquainted with REIGHARD'S observations upon *D. vaga*, and *D. multibranchiata* has since been described. Of BOUSFIELD'S seven species,

four: viz. *D. latissima*, *D. perrieri*, *D. mülleri*, and *D. acuta*, are described for the first time by himself and not noticed by VAILLANT. The remaining three are *D. obtusa*, *D. limosa* (=*D. philippinensis*), *D. furcata* (=*D. palpigera*, and *D. rodriguezii*); *D. digitata* (*Nais digitata*, O. F. MÜLLER) is mentioned as 'doubtful.'

The species not referred to by BOUSFIELD, but included in this genus by VAILLANT are *Pristina flagellum* of LEIDY, *Aulophorus oxycephala* of SCHMARDA, *Xantho decapoda* of DUTROCHET; *D. palpigera* and *D. philippinensis* are considered to be distinct species. *P. flagellum* does not seem like to be referable to the present genus by reason of the fact that the dorsal setae commence from the very first—that there is no cephalization like that of *Dero*. It is just possible that *P. flagellum* belongs to my genus *Branchiura*. *D. decapoda* is too imperfectly known to permit of its being regarded as a distinct species. It is said to have ten appendages from the branchial area.

D. palpigera is so imperfectly described by GREBNITZKY that I have no wish to criticize the view advanced by SEMPER that it is the same as his *D. rodriguezii*, and by BOUSFIELD that both are identical with *D. furcata*.

It is very difficult to identify *Xantho hexapoda* of DUTROCHET, *Nais auricularis* of BOSC, which BOUSFIELD regards, and with great probability as a *Dero*, and *Aulophorus discocephalus* of SCHMARDA. No doubt BOUSFIELD is also right in stating that it is impossible to identify *D. digitata* of MÜLLER. I do not admit for the present *D. stuhlmanni* of STIEREN. The only distinctive character appears to be its very small size (2 mm.), though size is sometimes, I believe, a reason for specific distinction.

D. intermedia of CRAGIN is doubtful. *Nais caudata* of SCHMARDA, with lengthened posterior segment, may also be a *Dero*.

(1) Dero mülleri, BOUSFIELD.

D. mülleri, BOUSFIELD, J Linn. Soc. 1886, p. 104.

Definition. *Length*, 13 *mm.; number of segments* 95. *Branchial processes, oblong, quadrangular, lower longest. Hearts usually seven pairs. Hab.—Great Britain.*

This species is easily to be distinguished on account of the peculiar form of the branchial processes.

(2) Dero limosa, LEIDY.

D. limosa, LEIDY, Am. Nat. 1880, p. 421.

D. philippinensis, SEMPER, Arb. Zool. Zoot Würzb. 1877/78, p. 107.

D. acuta, BOUSFIELD, Rep. Brit. Ass., 1885, p. 1098.

Definition. *Length*, 6 *mm.; number of segments* 60. *Branchial area with dorsal lip which*

is prolonged into two moderately long processes. Five pairs of contractile hearts. Hab.—Europe; N. America; Philippines.

Bousfield (**3**) insists upon the identity of Leidy's and Semper's species with a *Dero* studied and figured by himself. I am a little uncertain whether a species, concerning which I gave a few anatomical details a year or two since, and which I have already referred to as living inside the dead stems of water plants, is also identical. If so, there are six pairs of hearts and not five, and the first of these give off a branch on either side running forward. The hearts are in segments vi–xi, and those of vii, viii, ix are stouter than the rest. I regard *D. acuta* of Bousfield as merely a variety of the above; the branchiae are said to be longer. In this Stieren agrees.

(3) **Dero furcata,** Oken.

D. furcata, Oken, Lehrb. d. Naturg. iii, Pt. i, 1815, p. 363.
? **D. palpigera,** Grebnitzky, Zapiski novoross. Obstch. Est. 1873, p. 268.
? **D. rodriguezii,** Semper, Arb. Zool. Zoot. Würzb. 1877/78, p. 106.

Definition. *Number of segments 35. Dorsal setae bundles commence in the fifth segment. Body ends in two long processes, and there are also a pair of supplementary branchiae at sides. Five pairs of contractile hearts. Hab.—Europe; Trinidad*

This species was obtained by Bousfield from the inside of dead stems in water from the Royal Botanic Gardens, Regent's Park, by Semper from Minorca; I have received apparently the same species from Eastern tropical Africa. Bousfield, after remarking that '*D. rodriguezii* is undoubtedly the same as the *A. vagus* of Leidy, *D. furcata* of Oken, and *D. palpigera* of Grebnitzky,' omits the second name in his list of synonyms. Semper's figure (**1**, Taf. iv. fig. 15) represents the supplementary branchiae as springing from the anal area like the other branchiae. Stieren received this species from Trinidad.

(4) **Dero perrieri,** Bousfield.

D. perrieri, Bousfield, Rep. Brit. Ass. 1885, p. 1098.
D. obtusa, Perrier, Arch. Zool. Exp. 1872, p. 65.

Definition. *Number of segments, 35. Branchial area with entire margin. Hearts three to five pairs. Hab.—Europe.*

Bousfield is, no doubt, right in distinguishing between *D. obtusa* of d'Udekem and *D. obtusa* of Perrier. The entire margin of the gill-area in Perrier's species

is not found in the true *D. obtusa*. It is probably this species whose anatomy I myself described (**22**).

(5) Dero obtusa, D'UDEKEM.

D. obtusa, D'UDEKEM, Bull. Acad. Roy. Belg. xxii, pt. ii, 1855, p. 549.

Definition. *Number of segments,* 50. *Branchial area with distinct dorsal lip marked off by deep grooves on each side; branchiae rather short. Hearts usually four in number. Hab.—Europe.*

BOUSFIELD (**1**) remarks that 'this species shows the first trace of the modification which leads to the formation of supplementary branchial processes in the distinct demarcation of the dorsal lip, at the angles of which they are borne by those species which possess them.'

(6) Dero vaga (LEIDY).

Aulophorus vagus, J. LEIDY, Am. Nat. 1880, p. 423.

D. vaga, L. VAILLANT, Annelés, p. 383.

Definition. *Length, about* 8 *mm.; number of segments,* 25. *Body ending in two long processes; branchiae rudimentary, only two slight processes. Dorsal setae bundles consisting of one capilliform, and two pectinate setae. Perivisceral corpuscles present. Contractile hearts in VIII, IX, X. Hab.—N. America; Trinidad.*

This species, imperfectly described by LEIDY (**10**), has been more fully studied and illustrated by REIGHARD. The most marked characteristic of the species is the very rudimentary condition of the branchia, and the existence of two long processes, as in *D. furcata*. The vascular loops in the branchial region are correspondingly simple. The dorsal vessel bifurcates a little in front of the tail, and joins a circular vessel, which is again connected with the ventral vessel. On either side of the point, where the ventral vessel arises, a slender trunk springs and forms a low loop in the two rudimentary branchial processes, and there joins the dorsal vessel, just after its bifurcation. The 'spade-shaped' setae of the dorsal bundles are peculiar to this species. Their outer ends are flattened, the expansion being supported by two or three ribs. STIEREN received examples from Trinidad.

(7) Dero latissima, BOUSFIELD.

D. latissima, BOUSFIELD, Rep. Brit. Ass. 1885, p. 1098.

Definition. *Number of segments,* 40. *Four pairs of hearts. Branchial area with entire margin, wider than long; branchiae long. Hab.—Great Britain.*

This species has been described by BOUSFIELD in two papers (**2**, **3**), in the later of which (**3**, Pl. iv. fig. 8) the branchial area is illustrated. The definition does not appear to me to be enough to distinguish it from *D. perrieri*, but, as BOUSFIELD has examined both species, I leave it.

(8) **Dero multibranchiata**, STIEREN.

D. multibranchiata, STIEREN, SB. Dorpat. Nat. Ges., 1892, p. 103.

Definition. *Length, 8mm.; number of segments, 65. Branchiae fourteen in number, elongated. Hab.—Trinidad.*

This species, which has been somewhat fully described by STIEREN (with a few illustrations), is, of course, to be distinguished by the gills. The shorter dorsal setae do not appear to be bifid.

Genus **CHAETOBRANCHUS**, BOURNE.

DEFINITION. Fore end of body with a series of pairs of hollow processes of the body-wall, which enclose the dorsal setae, gradually diminishing in size posteriorly. Dorsal setae, which commence in second segment, capilliform, increasing in length up to about the tenth segment; thence diminishing in posterior segments; sickle-shaped setae also present; ventral setae entirely uncinate. No glandular stomach.

This is quite the most remarkable genus of the family at present known. Its distinguishing feature is the presence of a double series of long hollow processes of the integument, which enclose the dorsal setae, at least in the anterior segments; posteriorly—from the forty-second segment onwards, according to BOURNE'S figure (**1**, Pl. xii. fig. 1), some of the dorsal setae are not so enclosed. These branchial processes, as BOURNE assumes them to be, diminish in size after the first dozen pairs until 'they become mere warts on the surface of the worm, and in the posterior segments are entirely absent.' There are from sixty to seventy pairs of them. Each process is hollow, its interior communicating with the coelom; the walls are formed of epidermis alone, the muscular layers of the body-wall being apparently not prolonged into it; the epidermis has a cuticle, through which project very fine cilia; at the extremity are a few stiff hairs, doubtless of sensory function, and similar to hairs generally distributed over the body in the lower Annelids. Each branchial process contains a vascular loop, which is derived from the circular vessel

uniting the dorsal and ventral trunks of its segment. At present there are only three other Oligochaeta in which branchial processes exist, viz. *Dero*, *Branchiura*, *Hesperodrilus branchiatus*, and *Alma nilotica* (=*Digitibranchus niloticus*); it is not, however, yet certain whether the latter worm is really an Oligochaet.

The setae of *Chaetobranchus* are arranged as in *Pristina* and *Naidium*, that is to say, there is no cephalization; both the dorsal and ventral bundles commence in the second segment. The dorsal setae are of two kinds; there are long capilliform setae, which vary in length, being longest in some of the anterior bundles; in the posterior bundles there are in addition sickle-shaped setae which have a straight shaft, and a curved, sickle-shaped extremity; these two extremes are connected by intermediate forms. The ventral setae are all uncinate; there are four to six of them in each bundle.

The viscera do not present any features of special interest. The alimentary canal differs from that of most Naids in having no glandular ventricle. Nephridia are present, but there are no data as to the segment in which they commence. BOURNE says that they resemble the nephridia of Naids generally. The coelomic corpuscles are round, and contain numerous olive-green granules; as they can pass from segment to segment, it is evident that the septa must be imperfect.

The vascular system consists of the usual dorsal and ventral trunks, which are connected in each segment by a pair of lateral vessels. The dorsal vessel is much pigmented.

There are no eye-spots.

Of the generative organs, unfortunately, nothing is known. The genus only contains one recognizable species at present, viz.—

Chaetobranchus semperi, BOURNE.

C. semperi, BOURNE, Q. J. M. S. vol. xxxi, p. 88.

Definition. *Length*, 25–50 *mm*. *Branchial processes*, 60–70 *pairs*. *Hab.—Madras.*

This species, of which a general account is given above, was discovered by BOURNE in a 'tank' in Madras town[1]. It lives in the weed, moving about freely, and not constructing any tube, though forming a burrow. All the individuals found were in an active state of multiplication by simple fission, and were in no case sexually mature. BOURNE considers that this Naid is either identical with, or closely allied to, the worm described by SEMPER (1) as occurring along with *Dero philippinensis*.

[1] I found specimens in the *Victoria regia* tank at the Botanical Society's Gardens, Regent's Park.

Genus AMPHICHAETA, TAUBER.

DEFINITION. Prostomium elongate. Setae in four rows; several segments without setae after second setigerous segment No perioesophageal vessels. Sperm-sacs and egg-sacs present; no genital setae.

This genus was first described by TAUBER (**1**); the description, however, is limited to the following brief definition:—

'Praestomium dilatatum. Os inferum. Fasciculi uncinorum tam dorsalium quam ventralium.'

This definition is nevertheless sufficient to show that the worm in question is different from *Chaetogaster*. The genus has been fully established by the investigations of KALLSTENIUS. Previously to the paper of the last-named, LEVINSEN (**2**) had sought to identify *Amphichaeta* with *Uncinais*. Since LEVINSEN wrote upon this subject *Uncinais* has been re-investigated by BOURNE (**5**); and there is no longer any doubt of the complete distinctness of these two Oligochaeta.

In the most distinctive feature of the organization of the Chaetogastridae, *Amphichaeta* agrees with *Chaetogaster;* there are, that is to say, a considerable number of segments intercalated between the second and third seta-bearing segment; in *Chaetogaster* there are six intervening between the first segment and the second segment, provided with ganglia. The oesophageal segment has no setae; in *Amphichaeta* there are the same number; but as there are two ventral bundles of setae immediately following the mouth, and as the oesophageal segment is provided with setae, the same number of ganglia separate the anterior and the posterior seta-bundles.

This genus also differs from *Chaetogaster* in the absence of a perivisceral vessel in the oesophageal segment. A peculiar fact about the nephridia is their asymmetrical condition; they commence in the segment following that which contains the ovaries; occasionally they are symmetrical (paired), but more often one or other only of the two nephridia of a segment are present; they are closely adherent to the ventral blood-vessel, and are entirely without a pre-septal portion, that is, there is no funnel.

The reproductive organs have been fully described by KALLSTENIUS; the two testes lie in the segment immediately following the oesophageal; they arise from the peritoneum covering the nervous cord; the unpaired ovary arises in a similar fashion in the next segment; the efferent apparatus of the testes consists of the usual funnel-duct and terminal gland; it opens on to the ovarian segment; an

important difference between *Amphichaeta* and *Chaetogaster* is the presence in the former genus of sperm-sacs and egg-sacs; these are situated dorsally to the intestine, and consist of outgrowths of the anterior septa of the testicular and of the ovarian segments; they extend, when fully developed, into the third segment after the ovarian segment; the sperm-sac comes to lie within the egg-sac. These sacs are not found in *Chaetogaster*. A further difference from *Chaetogaster* is in the absence of genital setae. The ventral setae of the ovarian segment are quite absent in fully mature worms. This segment, as well as the one in front, is occupied by the clitellum. The testicular segment contains, in addition to the testes, the spermathecae; these are placed behind the anterior septum of that segment.

The genus *Amphichaeta*, although it should clearly be placed in the formerly-used family Chaetogastridae, on account of the peculiar 'cephalization' and the structure of the alimentary canal, differs from that family, and approaches the Naidomorpha in the presence of sperm-sacs and of egg-sacs; the absence of genital setae removes it from other Chaetogastridae, and brings the genus near to such a genus as *Dero*, where, as I have shown, there are no genital setae; as a rule, these setae are present in the Naidomorpha.

(1) Amphichaeta leydigi, TAUBER.

A. leydigi, TAUBER, Ann. Dan. 1879, p. 76.

Definition. *One seta in first bundle,* 2–4 *in the rest. Hab.—Denmark; Germany.*

(2) Amphichaeta sannio, KALLSTENIUS.

A. sannio, KALLSTENIUS, Biol. Fören. Förh. 1892, p. 54.

Definition. *Length,* 1·5 *m.; four setae in each of three anterior seta-bundles, afterwards three. Hab.—Sweden; Baltic.*

Genus CHAETOGASTER, VON BAER.

Syn. **Nais**, LAMARCK, &c. (in part).
Mutzia, VOGT.
Derostoma, DUGÈS.

DEFINITION. Ventral seta-bundles only present, composed of uncinate setae. The first in segment II. Segments III–V without setae at all (except in *Ch. filiformis*)**. One pair only of commissural blood-vessels.**

I follow LANKESTER (note appended to BOURNE'S paper 5) in relegating the genus *Chaetogaster* to the family Naidomorpha; so long as the genus *Chaetogaster* alone was known, the entire absence of the dorsal seta-bundles might possibly be held to be of sufficient importance to keep it as the type of a distinct family, though doubtfully, in view of analogous differences in the family Enchytraeidae; now, however, that another genus, closely allied to *Chaetogaster*, viz. *Amphichaeta*, is known, there is not this excuse for retaining the family; no other structural differences of first-rate importance support such a separation of the Chaetogastridae as a distinct family. The absence of the ventral setae in a number of the anterior segments (not from the first) was a peculiarity which might possibly merit emphasis of this kind, were it not for an analogous absence from two segments of the ventral setae in *Ripistes macrochaeta*. The reproductive organs, whose modifications are frequently of family value, are constructed upon precisely the same lines as in other Naidomorpha; and the spermathecae, testes, &c., are in the same segments in both of the 'families' Naidomorpha and Chaetogastridae. I have mentioned as a characteristic of the genus the fact that there is only a single pair of commissural vessels uniting the dorsal and ventral vessels; this is not absolutely distinctive, since BOURNE found, and I have been able to confirm his discovery, that in *Pristina equiseta* there is but a single pair of such vessels. A marked characteristic of the present genus is the series of dilatations of the oesophagus; in *Ch. crystallinus*, for example, there are two of the dilatations following the pharynx; each is covered with a network of blood-vessels; they, no doubt, correspond to the 'magen-ähnliche' dilatation in many Naids. But they are absent in *Ch. filiformis*, which is very Naid-like.

The absence of an intimate correspondence between the nerve ganglia, the inter-segmental septa, and the setae is remarkable. The first septum occurs behind the pharynx and there are three ganglia in front of it, to which there are only one pair of setae bundles.

The remarkable double character of the ventral nerve cord in the anterior segments has already been commented upon.

The nephridia of the genus, like those of *Amphichaeta*, are without a funnel; the place of this is taken by a rosette-shaped bunch of cells attached to the anterior septum of the segment by a few muscle fibres. The development of the nephridium has been traced by VEJDOVSKY, who found no trace of a funnel at any time; the earliest stage which he figures consists of three cells, all of them lying *behind* the septum. The mature organ consists of tubes running parallel to each other for the greater part of their course; they are connected by numerous small tubules, which also branch within the secreting cells.

As to the species of the genus, VAILLANT allows seven; but two of these are, as he himself admits, doubtful; the two doubtful species are *Ch. filiformis* of SCHMARDA and the *Derostoma laticeps* of DUGÈS. With regard to the former, which is figured, though very insufficiently, it is certainly a member of the genus. SCHMARDA figures setae upon *every* segment of the body. It comes from Curaca, in South America; I have examined a specimen from Valdivia. *Derostoma laticeps*, at first referred by DUGÈS to the Planarians, was afterwards (**3**, p. 30) placed in the genus *Nais;* but no particulars are given save that there is only a single set of setae on each side of the body, and that the 'lip' is large (suggestive, as VAILLANT has pointed out, of an *Aeolosoma*). Whether *Ch. gulosus* of LEIDY (**3**, p. 124) is a 'good' species or not seems doubtful. There is really nothing in the description which is at all decisive in the matter. Its length is one line, and there are five or six setae in each bundle. The oesophagus is said to be short.

I allow the five following species, and I use VEJDOVSKY'S names. This because it does not seem to me to be possible to identify the *Nais vermicularis* of MÜLLER. The only distinguishing feature of it is its length (2 lines). That possibly brings it nearer to *Ch. diastrophus*, but the identification does not appear to me to be certain.

(1) Chaetogaster limnaei, v. BAER.

Ch. limnaei, v. BAER, Nov. Act. Nat. Curios., 1827, p. 611.
Ch. furcatus, EHRENBERG, Symb. Phys., 1828.
Ch. diaphanus, OERSTED, Nat. Tidsskr., 1842, p. 138 (in part.).
Ch. vermicularis, GRUBE, Arch. f. Nat., 1851, p. 353 (in part.).
Mutzia heterodactyla, VOGT, Arch. f. Anat. Phys., 1841, p. 36.

Definition. *Length, 2 mm.; oesophagus much reduced. Hab.—Europe.*

This species lives parasitically upon fresh-water Mollusca and sometimes within their bodies. It is the smallest species of the genus. The anterior pair of setae are commonly somewhat stronger than the rest. The first pair of nephridia open in front of the second setae bundles.

(2) Chaetogaster diaphanus, GRUITHUISEN.

Ch. niveus, EHRENBERG, Symb. Phys., 1828.
Ch. diaphanus, OERSTED, Nat. Tidsskr., 1842, p. 138 (in part.).
Ch. vermicularis, GRUBE, Arch. f. Nat., 1851, p. 353 (in part.).
Nais diaphana, GRUITHUISEN, Nov. Act. Nat. Curios., 1828, p. 409.
Nais lacustris, DALYELL, Powers of Creator, vol. ii, 1853, p. 130.
Nais scotica, JOHNSTON, Cat. Worms B. M., 1865, pp. 71 and 336.

Definition. *15 mm. in length; oesophagus very distinct but shorter than pharynx. Hab.—Europe.*

This species is the largest of the genus and completely transparent.

VEJDOVSKY considers that the *Ch. diaphanus* of D'UDEKEM (**4**), who described the genitalia, is not the same species, but is *Ch. cristallinus.* VAILLANT, by omitting this particular reference from his list, seems to concur. I would point out that the 'yellow globules' described and figured by DALYELL are probably the ripe ova. The genital organs of *Ch. cristallinus* are, however, unknown, and D'UDEKEM'S *Ch. diaphanus* is only 5 mm. long, which better suits *Ch. cristallinus.* I include *N. scotica* as a synonym on the authority of JOHNSTON, who regarded it as being the same as DALYELL'S *N. lacustris.*

(3) Chaetogaster cristallinus, VEJDOVSKY.

Ch. cristallinus, VEJDOVSKY, SB. Böhm. Ges., 1883, p. 220.

Definition. *Length, 2–3 mm. Dorsal and ventral blood-vessels not continued into pharyngeal region. Oesophagus as long as pharynx. Hab.—Europe.*

This species was first described, and was later (**24**) more fully described and figured, by VEJDOVSKY. VAILLANT regards, I think with some reason, LANKESTER'S *Ch. niveus* as probably identical with this species. The principal reason for the identification is the long oesophagus. The dorsal vessel of this species ends in a bunch of cells abruptly; just before its termination it passes through a sling attached to the first dissepiment.

(4) Chaetogaster filiformis, SCHMARDA.

Ch. filiformis, SCHMARDA, Neue wirbell. Thier., I. ii, 1861, p. 11.

Definition. *Length, 2 mm. Prostomium well developed; no missing ventral setae. Hab.—S. America.*

This species is curiously intermediate between *Nais* and the typical *Chaetogaster.* It has no dorsal setae as in *Chaetogaster;* but it has a well-developed prostomium, and no narrow oesophagus, in which points, of course, it departs from *Chaetogaster.*

(5) Chaetogaster diastrophus, GRUITHUISEN.

Ch. vermicularis, GRUBE, Arch. f. Nat., 1851, p. 353 (in part.).

? **Ch. mülleri,** D'UDEKEM, Bull. Ac. Roy. Belg., xxii., pt. ii, 1855, p. 554.

Nais diastropha, GRUITHUISEN, Nov. Act. Nat. Curios., 1828, p. 417.

Definition. *Length, 2–5 mm. Oesophagus as long as pharynx. Blood-vessels quite normal. Hab.—Europe.*

VEJDOVSKY thinks that D'UDEKEM'S *Ch. mülleri* (which the latter ought to have called '*vermicularis*'—as he puts this name down as the only synonym) is identical with *Ch. diastropha*. It is to be distinguished, according to D'UDEKEM, from *Ch. limnaei* only by fewer setae and absence of 'spicules épidermiques.' These latter processes (=tactile hairs) are figured by VEJDOVSKY in *Ch. diastrophus*, so the identification is less certain. VAILLANT believes (p. 450) that D'UDEKEM'S *Ch. mülleri* is *Ch. diaphanus*; the difference in size may be, he thinks, a matter of age; but this does not seem likely, the difference being too great. VEJDOVSKY figures (**24**, Pl. vi, fig. 12, *chp*) a small chitinous plate upon hinder median aspect of brain, the nature of which is mysterious.

FAMILY ENCHYTRAEIDAE.

DEFINITION. **Setae (absent in *Anachaeta*) short, straight, or curved, not bifid at extremity. A single pair of calciferous glands sometimes present. Dorsal blood-vessel only present anteriorly, sometimes with cardiac body. Testes in XI, male pores on XII; a reduced spermiducal gland present; oviducts represented by pores. Spermathecae, one pair[1] in V generally opening into gut, with or without diverticula. Dorsal pores occasionally present.**

This family of Oligochaeta is very numerous in species, which are all of small size, ranging from a length of 3 mm. to 40 mm. The structure of the Enchytraeidae has been mainly elucidated by VEJDOVSKY (**3**, **20**), EISEN (**13**), and MICHAELSEN (**1–5**, **16**); to a less degree by D'UDEKEM (**3**), CLAPARÈDE (**3**), and UDE (**1**, **2**). MICHAELSEN has recently published a detailed 'Synopsis' of the family, the conclusions set forth in which are, in the main, adopted here. The family is a very natural one; there appear to be no forms transitional between the group and other Oligochaeta. This is satisfactory to the systematist, but it renders the labours of the naturalist who desires to study the inter-relationships of the different groups of Oligochaeta extremely difficult.

All the Enchytraeidae have a prostomium; in most there is a single pore upon the prostomium; in a few forms (e.g. in *Fridericia galba*) there are also dorsal

[1] *Henlea puteana* with *two* pairs is the only exception.

pores; this family is the only one of the aquatic Oligochaeta which have dorsal pores. The setae are entirely absent in *Anachaeta;* there are only two bundles in *Distichopus* (if this genus be really an Enchytraeid), but six in *Chirodrilus* (concerning which genus also more information is wanted); all the others have the usual four bundles of setae to a segment. The setae are either straight or bent in the prevalent ʃ-shape; their extremities are never cleft. The setae in this family are always short and generally fairly numerous in each bundle. One genus only is entirely achaetous—the genus *Anachaeta*. The setae are here represented by large cells which depend into the body-cavity (see p. 5). The setae when present are of two kinds; there are curved sigmoid setae and straight setae; the former are found in certain genera, such as *Pachydrilus;* and the latter in other genera, such as *Enchytraeus*. The setae of a bundle are disposed in a fan-like fashion, the setae on one side of a bundle diverging from those upon the other side. The number of setae in a bundle varies from one (*Enchytraeus monochaetus*) or two (*Fridericia bisetosa*) to fourteen, which is the greatest number that has been hitherto recorded (in *Pachydrilus minutus*). Very commonly there is an inequality in number between the setae of the lateral and ventral bundles respectively; in this case, the lateral bundles have usually the fewest setae; thus in *Pachydrilus pagenstecheri* there are 7–10 setae in the ventral bundles and 3–5 in the lateral. The setae of a given bundle are usually of a size; but this is not always the case; the most conspicuous exception is seen in the genus *Fridericia;* here the outer setae of a bundle are always larger than the inner, which are at the same time the younger. There are sometimes differences in size between the setae of the four bundles of a given segment; for example in *Fridericia bulbosa* the setae of the lateral bundles are smaller than those of the ventral. In *Mesenchytraeus setosus* there is something like a formation of genital setae; the lateral bundles of segments v–viii (inclusive) are made up of 1–4 setae, which are very much larger than those of adjacent segments. In *Enchytraeus monochaetus* the anterior setae are more slender than those of the posterior segments. *Enchytraeus monochaetus* is unique in the group by reason of the fact that the setae are entirely wanting upon the first few segments of the body. The nephridia are peculiar in their form; they are stout and solid-looking organs, often lobed, with a lumen which (according to Bolsius) forms a plexus in their interior. They frequently begin as far forward as the second segment, though they are wanting in those segments which contain the generative organs. Some Enchytraeidae are characterized by the possession of a single gland, or a pair of glands, which seem to be the equivalents of the calciferous glands of other worms (see p. 61). The family is also characterized by

the position of the reproductive organs; the testes are in the eleventh segment[1]; the ovaries in the following segment. The sperm-ducts open by a very reduced spermiducal gland on to the twelfth segment; the funnel of these ducts is peculiar in form, being generally extremely long and of a glandular appearance; the oviducts are represented merely by pores; or rather by a short prolongation of the septum which meets the pore; they seem to be degenerate. The spermathecae are far forward opening on to the intersegmental furrow iv/v; as a rule they open into the gut, a fact which is paralleled in the genus *Sutroa*, and was first discovered in the present family by MICHAELSEN (**14**). Egg-sacs and sperm-sacs are only present in *Mesenchytraeus*. The above characters distinguish the Enchytraeidae from all other Oligochaeta.

MICHAELSEN allows twelve genera, of which two (not described by himself) must be considered doubtful; these genera are *Chirodrilus* and *Distichopus;* I shall recur to them presently. To these *Bryodrilus* of UDE (**2**), and *Parenchytraeus* of HESSE must be added.

The genera which appear to be valid may be thus distinguished:—

MESENCHYTRAEUS.	Setae ∫-shaped; no dorsal pores, only a head-pore; origin of dorsal vessel postclitellian, contains a glandular body.
STERCUTUS.	Setae ∫-shaped; origin of dorsal vessel anteclitellian, contains a glandular body.
PACHYDRILUS.	Setae ∫-shaped; no dorsal pores; blood coloured; dorsal vessel originates behind clitellum, contains no glandular body.
BUCHHOLZIA.	Setae ∫-shaped; dorsal pores absent; dorsal vessel originates from the tip of the single dorsal diverticulum of the gut; salivary glands present.
HENLEA.	Setae straight or ∫-shaped; origin of dorsal vessel anteclitellian; no dorsal pores; oesophagus sharply marked off from intestine.
ENCHYTRAEUS.	Setae straight; dorsal vessel postclitellian in origin.
FRIDERICIA.	Setae straight; dorsal pores present; salivary glands present; dorsal vessel postclitellian in origin.
ANACHAETA.	No setae; no dorsal pores; dorsal vessel anteclitellian in origin; a single salivary gland; spermathecae not opening into gut.

[1] In a few forms the testes, &c., are further forward.

MARIONIA. Setae ʃ-shaped; no dorsal pores and other characters as in *Pachydrilus*, except that testes are massive, not subdivided.

BRYODRILUS. Setae ʃ-shaped; no dorsal pores; dorsal vessel arising behind oesophageal glands in xii; blood colourless.

PARENCHYTRAEUS. Setae straight; no dorsal pores; ventral vessel bifurcates only in first segment.

The arrangement of the genera of this family naturally depends upon the affinities of the family as a whole to other Oligochaeta. Regarding, as I believe it to be necessary to do, the more simple forms as standing higher or lower in the scale (according to the sense attached to the words) than the more complexly-organized genera, in fact, as more specialized through degeneration, it appears to me that the genus *Mesenchytraeus* represents, on the whole, the most primitive Enchytraeid. I base this view of its position on the following characters:—

(1) The setae are sigmoid in shape.

(2) There are sperm-sacs and egg-sacs.

On the other hand, the colourless blood, the absence of dorsal pores. and the rudimentary condition of the oesophageal glands (represented only by the cardiac body), furnish evidence against the placing of the genus.

The genus *Buchholzia* exhibits two of these last characters with the addition of the sigmoid setae; it has, however, colourless blood like *Mesenchytraeus*. *Pachydrilus* has coloured blood and sigmoid setae. How are we to decide between the conflicting claims of these three forms?

A fourth, indeed, might be added, viz. *Fridericia;* this genus has dorsal pores, a character distinctive of the higher Oligochaeta.

It seems to me that the importance of these several characters is indicated by their position in the following list:—

(1) Sperm-sacs and egg-sacs.

(2) Oesophageal glands } (equal).
Sigmoid setae }

(3) Red blood.

(4) Dorsal pores.

(1) Sperm-sacs are, with the exception of certain Enchytraeidae (the majority), present in *all* Oligochaeta, even in the lowly form *Aeolosoma*. They must evidently, therefore, be looked upon as being very distinctive characters of these Annelids.

(2) Oesophageal glands are met with in none of the lower aquatic Oligochaeta, excepting certain Enchytraeidae. They are very common in the higher forms, occurring in nearly all the 'earthworms.' Their presence or absence, therefore,

seems to be correlated with the aquatic or terrestrial life. There are, it will be observed, no reasons for inferring that such is the case with the sperm-sacs. I have bracketed together, as being of equal importance, the presence of these glands and the sigmoid character of the setae. It is perfectly true that sigmoid setae are found in all genera of Oligochaeta, excepting only certain Enchytraeids; but the weight of this fact is partly lessened by the fact that among the aquatic forms there are very generally also capilliform setae, and the sigmoid setae are variously modified in shape (e.g. pectinate setae).

(3) Red blood is only less universally present in the Oligochaeta than sigmoid setae. Apart from the Enchytraeidae, it stops short at the lower Naids, which have very faintly coloured blood; *Aeolosoma* has colourless blood. One can hardly help inferring from the facts that size is correlated with the colour of the blood; the minute Oligochaeta have 'white' blood, the larger and large forms red blood. Now the genus *Pachydrilus* contains some of the largest Enchytraeids (also, it must be admitted, some of the smallest).

(4) There remains only the question of the dorsal pores; I am of opinion that these are distinctly related to the habit of the worm; they are to be found in no aquatic Oligochaeta. The genus *Fridericia*, in which alone they exist (among the Enchytraeidae), is terrestrial, and found in the driest localities; so also it is true of many *Pachydrilus*, &c. But, on the whole, the group of the Enchytraeidae is, in the matter of its mode of life, in an undecided state; they are not purely terrestrial nor purely aquatic; and, if aquatic, neither definitely marine nor fresh water.

The presence, then, of egg and sperm-sacs, coupled with the sigmoid setae, leads me to place the genus *Mesenchytraeus* in the position of the nearest approach to the original Enchytraeid.

I do not, however, think that any other genus can be derived directly from *Mesenchytraeus;* it is itself too degenerate in the matter of oesophageal glands and the colour of the blood. Nearest to it I should place *Buchholzia*, *Pachydrilus*, and *Henlea*, which have oesophageal glands, and *Pachydrilus*-like setae; and the two last will stand nearer to *Mesenchytraeus* than *Pachydrilus*, in which all trace of the oesophageal glands has disappeared. *Fridericia* and *Enchytraeus* will be still further remote from the primitive stock, and *Anachaeta* furthest of all. I do not feel able to make any suggestions concerning *Distichopus* and *Chirodrilus*, of whose anatomy we have at present insufficient knowledge.

The following worms are either certainly or probably Enchytraeids.

Halodrilus littoralis of VERRILL, thought by VEJDOVSKY (**24**) to be a Tubificid.

seems to have oesophageal glands as in *Henlea*. The setae, disposed in a fan-like manner, suggest an Enchytraeid, as also their small size.

Lumbricus multispinus of GRUBE (**7**) (called *Echinodrilus multispinus* by VAILLANT) seems to be an Enchytraeid, as VAILLANT (**6**, p. 89), has suggested.

Lumbricus glacialis of LEIDY (**9**), regarded by MICHAELSEN as belonging to this group, is said to possess generative organs extending from the fourth to the eighth segment. This does not read like an Enchytraeid.

MICHAELSEN is, in my opinion, undoubtedly right in referring *Enchytraeus moniliformis* (D'UDEKEM), *Nais albida* (CARTER), *Lumbricus jordani* (WILLIAMS, **1**), and *Enchytraeus juliformis* (KESSLER), to this family. He is less certainly right in doing the same with *Saenuris abyssicola* and *S. limicola* of VERRILL, *Tubifex pallidus* (DUGÈS), and *Saenuris vagans* (JOHNSTON, **2**).

Enchytraeus sepultus of MENGE, a fossil species from amber, is an undefined species.

Lumbricus putridinis, synonymous, according to JOHNSTON (**2**), with *Enchytraeus vermiculus*, only needs to be referred to for the sake of completeness.

The number of species in this family is considerable; the names that have been given to supposed species is greater still. One hundred and three names are quoted in MICHAELSEN'S Synopsis as applicable, or which have been applied, to worms belonging to this family. VAILLANT allows no less than seventy-two of these in a way; they are at any rate numbered and described in his work, though he doubtless casts some question upon the reality of certain among them. MICHAELSEN allows only sixty-one species (several of which are not included in VAILLANT'S work, as they have been described since 1886); in addition to these sixty-one, he mentions twenty-nine which are partly 'incertae sedis,' partly 'species inquirendae,' and partly 'species spuriae.' To the first category are referred such species as can be defined specifically, but whose generic position is uncertain. To the second category are referred those species which are insufficiently characterised, but which may be subjected to renewed examination since the original types are extant, or since the description given is enough with the locality to ensure recognition should they be again met with. To the last category are referred a few species which are quite hopeless in these possibilities. Some of these species have been dealt with in the pages which follow; others may be suitably referred to here.

The following five species are described by EISEN (**13**) under the generic name of *Archienchytraeus*:—

(1) *Archienchytraeus tenellus*.
(2) " *levinsenii*.
(3) " *lampas*.
(4) " *gemmatus*.
(5) " *ochraceus*.

MICHAELSEN says of these species that they are definable as species, but that it is uncertain whether they belong to the genus *Henlea* or *Enchytraeus*. I am not able to elucidate the matter any further, and therefore leave these species in the position in which MICHAELSEN placed them.

About the following genera we require further information.

Genus DISTICHOPUS, VERRILL.

DEFINITION. **'Form and colour as in *Enchytraeus*, with a well-produced girdle. Setapods in a single row on each side ventrally, in divergent fascicles of four in advance of the girdle and of three behind it.'**

There is but one species in this genus which is regarded by MICHAELSEN as a 'species inquirenda.' This species, called *D. sylvestris*, is 20–30 mm. in length and composed of sixty-eight segments.

Genus CHIRODRILUS, VERRILL.

DEFINITION. **'Allied to *Saenuris*, but with six fan-shaped fascicles of setae upon each segment, two of which are ventral, two lateral, and two sub-dorsal; setae in the ventral and lateral fascicles four to nine, simple, acute, slender, curved like an italic *ʃ*; those of the dorsal fascicles stouter and less curved, three to six in each fascicle. Intestine wide, somewhat moniliform. Anus terminal, large.'**

I follow MICHAELSEN in assigning this genus to the family Enchytraeidae. Both VEJDOVSKY and VAILLANT place it among the Tubificidae. As MICHAELSEN has pointed out (5), the shape of the setae and the colourless blood together are inconsistent with any other view upon the systematic position of the two species which comprise the genus. The clitellum, too, is developed (in *C. larviformis*) upon the eleventh seta-bearing segment and upon a small part of the following segment, which is precisely what occurs in other Enchytraeids. The two species of the genus described by VERRILL are *C. larviformis* and *C. abyssorum*; they were both dredged in Lake Superior. In *C. abyssorum* the dorsal-setae are described as being shorter than those of both lateral and ventral bundles. Both species are small, 6 or 8 mm. in length, with thirty-eight or forty-two segments—another argument, not noticed by MICHAELSEN—for their being referred to the Enchytraeidae.

Genus MESENCHYTRAEUS, EISEN.

Syn. **Analycus**, LEVINSEN.
Enchytraeus, VEJDOVSKY (in part.).
Neoenchytraeus, EISEN (in part.).
Pachydrilus, VAILLANT (in part.).

DEFINITION. **Setae *ʃ*-shaped, usually more numerous in the ventral than in dorsal bundles of anterior segments. Head-pore usually near to anterior end of prostomium, no dorsal pores. Dorsal vessel arises behind clitellum, contains a cardiac gland, blood colourless. No salivary glands. Brain truncated or concave posteriorly, generally broader than long. Nephridia with short ante-septal and large irregularly lobate post-septal portion. Egg-sacs and sperm-sacs present; sperm-ducts short, at most eight times as long as funnel.**

The term *Mesenchytraeus* was first applied by EISEN to a few species, which were grouped together as a subgenus of *Enchytraeus.*

It was thus defined:—'The spermatozoa, as long as they remain in the perivisceral cavity of the body, or in the vesicle of the efferent duct, are not free, but encysted or congregated into small globules surrounded by a membrane. The supra-oesophageal ganglion is deeply divided in front, but straight behind or nearly so, the emargination being very inconsiderable. The tube of the efferent duct is unusually short and broad, never more than six or eight times longer than the vesicle of the said organs.'

It will be observed that the two last of these characters are retained in MICHAELSEN'S definition, of which the above is substantially a reprint. As to the spermatozoa, MICHAELSEN does not use the point in his re-definition of the genus or in his revision of the Enchytraeidae (5). In an earlier paper, however, (upon *Archienchytraeus möbii*) he remarks:—'Bedeutende Abweichungen kann ich von *P. beumeri* constatiren. Bei diesem Wurm zerfallen die Hoden in einzelne Zellgruppen. Diese Zellgruppen sammeln sich in zwei Säcken, die von Dissepiment XI/XII gebildet werden und rechts und links vom Darm in das XII. Segment hineinragen. In diesen Säcken machen dann die Zellgruppen ihre Entwicklung zu Spermatozoen durch. Soweit ich ihre Entwicklung verfolgen konnte, ungefähr bis zu dem Stadium, welches von *E. möbii* in III, 6. V gezeichnet ist, bleiben die einzelnen Gruppen von einem feinem Häutchen umschlossen, wie es auch Eisen für die Mesenchytraeen, zu denen *P. beumeri* nach dem System dieses Autors gehört, feststellt.'

The matter evidently needs further inquiry. MICHAELSEN added two other characters of importance to the definition of the genus, viz. the presence of sperm- and egg-sacs, and the peculiar form of the nephridia. Besides describing several new forms referable to this genus, MICHAELSEN rescued a species (*N. fenestratus*) from EISEN'S genus *Neoenchytraeus*, and assigned it to *Mesenchytraeus.* EISEN himself distinguished *Mesenchytraeus* from *Neoenchytraeus* partly on account of the form of the brain; in the former, the posterior margin is straight or slightly concave; in the latter, it is convex; now, in *N. fenestratus*, the hinder margin of the brain is, as VAILLANT has pointed out (6, p. 249), so little convex that the worm ought to be assigned to the genus *Mesenchytraeus.* MICHAELSEN also drew attention to this similarity between two species, supposed by EISEN to belong to different sub-genera; he furthermore asserted from an examination of the species that the nephridia have the form so characteristic of the genus *Mesenchytraeus*, a fact which is not apparent in the figure given by EISEN (13, Pl. xiv, fig. 35). The sperm-ducts, too, are short, as they are in *Mesenchytraeus.* The identity of LEVINSEN'S genus *Analycus* with EISEN'S *Mesenchytraeus* seems to me to have been rightly established by MICHAELSEN. This identification rests chiefly upon the apparently similar form of the nephridia in the two genera. In addition there are other points of similarity which are dealt with in the following pages.

The main characters which mark this genus are given in the diagnosis; this diagnosis may now be expanded a little; the brain has two pairs of muscles attached to its posterior margin, one pair above, the other below. The nephridia are remarkable for the fact that the voluminous part of the organ, lying behind the septum, is lobate; this is brought out in EISEN'S figures, which are stated by MICHAELSEN to be, in some particulars, inaccurate; EISEN represents the tube as lost in a mass of surrounding tissue; MICHAELSEN says that the tube is so much and so closely coiled that there is but little of the cellular sheath visible, 'dass hier die umhüllende

Zellsubstanz fast auf das Minimum reducirt ist.' The part of the nephridium which lies in front of the septum is little more than the funnel. As regards the lobate character of the post-septal part of the nephridium, attention may be here directed to EISEN'S figure (**13**, Pl. xiv. fig. 38) of the nephridium of *Neoenchytraeus hyalinus*, a species put by MICHAELSEN into the genus *Enchytraeus*, as restricted by him. It would appear from this figure that the species should be referred to the genus *Mesenchytraeus*. Another peculiarity of the genus, though restricted to two species, *M. armatus*, *M. setosus*, is the existence of specially enlarged setae in certain segments of the body; these are referred to under the description of the species where they occur. The reproductive organs are remarkable in that there are, as in most Oligochaeta, though not in other Enchytraeidae, sperm-sacs and egg-sacs; the sperm-sacs are paired, the egg-sac is usually single; the varying length of these sacs may be useful as a specific character, but it seems more probable that the length varies according to age and degree of maturity. The spermathecae open at one end into the gut; they may or may not be provided with diverticula; when these are present they vary in number.

(1) Mesenchytraeus primaevus, EISEN.

Mesenchytraeus primaevus, EISEN, Öfv. Svensk. Akad. 1878, No. 3, p. 68.
Enchytraeus primaevus, VEJDOVSKY, Syst. u. Morph. 1884, p. 41.
Enchytraeus (Mesenchytraeus) primaevus, VAILLANT, Annelés, p. 269.

Definition. *Length*, 10 *mm.*; *breadth*, 1½ *mm.*; *setae*, 5–8 *per bundle*; *number of segments*, 52. *Spermathecae*, *very small*, *trilobed at free end*; *sperm-duct hardly longer than funnel*. *Hab.—Nova Zembla*; *Siberia*.

EISEN distinguishes this species principally by the excessive minuteness of the spermathecae, which are said to be 'at least ten times smaller' than those of other species. EISEN considers that this is not due to the immaturity of the organs though he confesses that no spermatozoa were found in them. The cardiac body is thick in cross section with irregular swellings, and composed of numerous cells.

(2) Mesenchytraeus mirabilis, EISEN.

Mesenchytraeus mirabilis, EISEN, Öfv. Svensk. Akad. 1878, No. 3, p. 68.
Enchytraeus mirabilis, VEJDOVSKY, Syst. u. Morph. 1884, p. 41.
Enchytraeus (Mesenchytraeus) mirabilis, VAILLANT, Annelés, p. 268.

Definition. *Length*, 10–15 *mm.*; *breadth*, 1½–2 *mm.*; *number of segments*, 64; *setae*, 5–7

per bundle. Spermathecae conical, with 4–5 globular diverticula; sperm-duct generally much longer than funnel. Hab.—Siberia.

This species, like the last, has been investigated by EISEN (**13**), and MICHAELSEN (**2**, **5**). The last-mentioned author deals with a few points not referred to by EISEN. He figures and describes the cardiac organ, stating that it agrees with that of the last species in being larger than that of *M. beumeri*, and in being composed of a considerable number of cells. There is (according to MICHAELSEN) a single sperm-sac, which extends as far back as the twenty-sixth segment; the median egg-sac reaches further back still, to the twenty-ninth segment. Both sacs are constricted where they pass through the septa; this constriction is shown in one of EISEN'S figures (**13**, Pl. xv, fig. 44); these figures indicate gaps between the anterior and posterior parts of the sperm-sacs.

(3) Mesenchytraeus falciformis, EISEN.

Mesenchytraeus falciformis, EISEN, Öfv. Svensk. Akad. 1878, No. 3, p. 68.
Enchytraeus falciformis, VEJDOVSKY, Syst. u. Morph. 1884, p. 41.
Enchytraeus (Mesenchytraeus) falciformis, VAILLANT, Annelés, p. 272.

Definition. *Length, 4–5 mm.; breadth, 3 mm.; number of segments, 50; setae, 5–6 per bundle. Spermathecae, long and narrow, without diverticula; sperm-duct six times as long as funnel. Hab.—Nova Zembla.*

The cardiac body is, according to MICHAELSEN (**2**), smooth and thin and composed of but few cells. The median egg-sac extends back as far as the nineteenth segment in the specimens examined by MICHAELSEN; EISEN figures the egg-sacs as paired structures reaching back to the sixteenth segment only.

(4) Mesenchytraeus fenestratus, EISEN.

Neoenchytraeus fenestratus, EISEN, Öfv. Svensk. Akad. 1878, No. 3, p. 74.
Enchytraeus fenestratus, VEJDOVSKY, Syst. u. Morph. 1884, p. 41.
Analycus glandulosus, LEVINSEN, Vid. Med. 1883, p. 232[1].
Mesenchytraeus fenestratus, MICHAELSEN, Abh. Nat. Ver. Hamb. 1889, p. 17.
Enchytraeus (Neoenchytraeus) fenestratus, VAILLANT, Annelés, p. 266.

Definition. *Length, 15–20 mm.; breadth, 1 mm.; number of segments, 60; setae, 5–7 per bundle. Spermathecae elongated without any diverticula; sperm ducts very short, not longer than funnel. Hab.—Siberia; Denmark.*

[1] LEVINSEN considers that his species = *Enchytraeus albidus* of TAUBER in part, the latter also including his (LEVINSEN'S) '*Analycus armatus*.'

The principal reasons which lead MICHAELSEN to identify this species with LEVINSEN'S *Analycus glandulosus* are (1) the fusion of the prostomium with the buccal segment, and (2) (apparently) the fact that the spermathecae are long sacs without diverticula; there is, moreover, nothing in the diagnosis of LEVINSEN which goes against the identification.

MICHAELSEN found that the head pore was (exceptionally for the genus) placed between the prostomium and the buccal segment. Sperm-sacs and egg-sacs appear to be paired.

(5) Mesenchytraeus flavus (LEVINSEN).

Analycus flavus, LEVINSEN, Vid. Med. 1883, p. 232.

Pachydrilus flavus, VAILLANT, Annelés, p. 245.

Mesenchytraeus flavus, MICHAELSEN, Abh. Nat. Ver. Hamb. 1889, p. 18.

Definition. *Length*, 15 *mm.; usually three setae in lateral and five in ventral bundles. Spermathecae with a single pear-shaped diverticulum; funnel comparatively small; sperm-duct very short. Hab.—Nova Zembla; Denmark.*

MICHAELSEN has identified an Enchytraeid found by him among three specimens of '*Neoenchytraeus vejdovskii*' as '*Analycus flavus*'; he naturally adds something to LEVINSEN'S very short account of the species. The egg-sac is paired and extends through at least segments xiii, xiv, xv. VAILLANT, in copying LEVINSEN'S diagnosis, has fallen into an error, by omitting to mention the appendix of the spermatheca; he says that the spermathecae are 'formées d'un conduit long et étroit sans appendices glandulaires et d'un sac pyriforme'; the latter is evidently the diverticulum and not, as VAILLANT'S description would lead one perhaps to infer, the swollen end of the pouch. The other characters of the species are to be found in the above definition.

(6) Mesenchytraeus beumeri, MICHAELSEN.

Pachydrilus Beumeri, MICHAELSEN, Arch. Mikr. Anat. 1885, p. 294.

Pachydrilus (Mesenchytraeus, EISEN) **Beumeri**, MICHAELSEN, Ench. Möb., 1886, p. 44 et passim.

Mesenchytraeus Beumeri, MICHAELSEN, Arch. Mikr. Anat. 1887, p. 372.

Definition. *Length*, 30 *mm.; Setae*, 3–5 *in lateral*, 5–8 *in ventral bundles*[1]. *Spermathecae*

[1] The actual numbers of setae are thus stated by MICHAELSEN:—

	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
Lateral .	3	3	3	3	3	3	3	3	3	3	0	5	5	5	4	5
Ventral .	5	8	8	8	7	7	8	7	8	7	0	5	5	7	6	6

long with two oval diverticula; sperm-duct eight times the length of the comparatively small funnel. Hab.—Germany.

This species has been described by Michaelsen in two papers quoted above. The species has two short sperm-sacs confined to the twelfth segment; the egg-sac is single, but in one instance it was found to be divided into two at its extremity; the egg-sac extends as far back as the nineteenth segment. The egg-sac in this species shows no constrictions at the septa, as is so often the case. The perivisceral corpuscles are ellipsoidal. The septal glands are in iv and v; from these a band passes back on each side as far as vii, from which arise irregular lumps of gland-cells. The dorsal vessel springs in xviii; it has swellings in this and the three segments lying in front. The clitellum occupies segments xi–xiii.

(7) Mesenchytraeus flavidus, Michaelsen.

Mesenchytraeus flavidus, Michaelsen, Arch. Mikr. Anat. 1887, p. 372.

Definition. *Length, 12 mm.; setae, up to five per bundle. Sperm-duct at most five times as long as funnel; spermathecae without diverticula, dilated at distal extremity. Hab.—Germany.*

The dorsal vessel arises in the thirteenth segment. The sperm-duct is only about five times as long as the funnel; it has small prostates. The clitellum occupies segments xi–xiii.

(8) Mesenchytraeus setosus, Michaelsen.

Mesenchytraeus setosus, Michaelsen, Arch. Mikr. Anat. 1888, p. 494.

Definition. *Length, 15 mm.; 1–12 setae per bundle, those of the lateral bundles of segments, V—VIII, much larger*[1] *than others, and fewer in a bundle. Spermatheca with a single short diverticulum, close to its oesophageal opening. Hab.—Germany.*

This species shares with the doubtful *M. armatus* the peculiarity in the setae

[1] The exact numbers in the bundles of anterior segments are, according to Michaelsen, as follows (large setae indicated in thick type):—

	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII
Right lateral .	3	4	4	**2**	**1**	**2**	**3**	3	3	4	0	3	4	4	4	5	6
Right ventral .	10	11	10	10	9	10	11	10	9	8	0	8	9	8	7	9	9
Left ventral .	9	11	12	10	7	9	10	8	8	9	0	8	8	8	9	8	8
Left lateral .	4	3	4	**1**	**1**	**2**	**4**	3	4	3	0	3	4	4	6	4	5

referred to in the definition. It is also remarkable in having more setae than any other Enchytraeid. MICHAELSEN does not mention the comparative lengths of the sperm-duct and the funnel which is often, apparently, a useful specific character. The clitellum is longer in extent than in any other Enchytraeid; it reaches from the eleventh to the fourteenth segment, occupying, however, but half of the first and the last of these segments. The egg-sac is single and extends below the gut to the eighteenth segment; the sperm-sacs are paired and do not extend beyond the fourteenth segment. The lymph corpuscles are flat and *Navicella*-like in form.

(9) Mesenchytraeus armatus (LEVINSEN).

Analycus armatus, LEVINSEN, Vid. Med. 1883, p. 232 [1].

Mesenchytraeus armatus, MICHAELSEN, Abh. Nat. Ver. Hamb. 1889, p. 18.

Definition. *Setae, 1–6 in a bundle, those of segments IV—VI (one or two to each segment) double the length of the rest. Hab.—Denmark.*

This species agrees with the last in the possession of large setae; it is to be distinguished from it by its smaller size, and also in the smaller number of setae in some of the segments.

Genus STERCUTUS, MICHAELSEN.

DEFINITION. **Setae as in** *Pachydrilus*. **Head-pores present. Dorsal vessel ante-clitellian in origin, with cardiac body; blood colourless. No salivary glands. Spermathecae not opening into gut.**

This genus, of which our knowledge is entirely due to MICHAELSEN, is in many respects remarkable. It appears to connect the genera *Mesenchytraeus* and *Buchholzia*; it has the cardiac body of the former genus, and the ante-clitellian origin of the dorsal vessel found in the latter. The other characters of the worm I shall regard as specific, and describe under the species—

Stercutus niveus, MICHAELSEN.

Stercutus niveus, MICHAELSEN, Arch. Mikr. Anat. 1888, p. 483.

Definition. *Length 6 mm.; number of segments 28; setae 3–4 per bundle. Funnel of sperm-duct small; spermathecae oval, with no constriction between pouch and duct; glands at base of latter. Hab.—Germany.*

[1] See footnote, p. 317.

The worm was called '*niveus*' on account of its very white appearance; it occurs in earth which had been manured with fish débris, and was, on that account, and also because of its look, mistaken at first for a Dipterous larva. No head-pore was found, and, if present, it must be but small. The brain is deeply cleft behind, and the two lobes formed by this furrow are slightly divergent, and have the appearance of distinct lobes, owing to this fact and to the presence of a shallow lateral depression at the side of the brain, just where they join the main mass; there are two pairs of muscles attached to the brain. The nephridia all have a short anteseptal part, and the duct arises near to the septum. The dorsal vessel springs from the intestinal sinus in the ninth segment; it contains a cardiac body. The intestine is mainly remarkable for the huge size of the peritoneal cells which clothe it. In the original description of the worm, MICHAELSEN mentioned as a character the absence of a lumen in the whole of the alimentary tract lying behind the pharynx; in the rectum the lumen was wholly obliterated, while in the intestine the lumen was blocked by stellate cells; that this is not characteristic either of the genus or even of the species, was subsequently shown by MICHAELSEN, who met with individuals living in ordinary garden mould, whose alimentary tract was quite normal; it is, therefore, doubtless with justice, that MICHAELSEN attributed the peculiar condition of the gut in the first studied specimens to the nature of their diet. It should be mentioned that the specimens found in ordinary earth had been placed there by MICHAELSEN; after two years they showed the normal gut-structure. The reproductive organs occupy the usual position. The funnels of the sperm-ducts are remarkable on account of their small size.

Genus PACHYDRILUS, CLAPARÈDE.

Syn. **Lumbricus**, O. F. MÜLLER (in part.).
Clitellio, LÜTKEN et alii (in part.).
Nais, O. F. MÜLLER (in part.).
Saenuris, HOFFMEISTER (in part.).
Enchytraeus, RATZEL et alii (in part.).
Archienchytraeus, EISEN (in part.).
Epitelphusa, DRAGO.
Lumbriculus, OERSTED.

DEFINITION. **Setae ʃ-shaped. Head-pore between prostomium and buccal segment, no dorsal pores. Brain incised behind; nerve-chord often with outgrowths in**

neighbourhood of genital segments. Blood yellow or red, dorsal vessel arises behind clitellum and is without cardiac body. No salivary glands. Testes multiple; sperm-duct long. Copulatory glands often present.

The genus *Pachydrilus* was instituted by CLAPARÈDE, but not defined in such a way as to distinguish it from *Enchytraeus;* in a subsequently published memoir he indicated the differences between *Pachydrilus* and *Enchytraeus,* whose near relationship he had not formerly appreciated. These differences are in the red blood of *Pachydrilus*, its living upon the sea-shore, and finally the absence of dorsal pores.

VAILLANT adopted this definition of the genus, with the exception of the marine habit; in his recent work upon the Oligochaeta he still adheres to it, modifying the definitions so as not to be universally applicable. With the exception of *Anachaeta* and *Distichopus* all the Enchytraeidae are referred to one of the two genera, *Pachydrilus* and *Enchytraeus*.

CLAPARÈDE'S distinctions were criticised by EISEN (**13**), who remarked that *Pachydrilus lacteus* had colourless blood, and that all the red-blooded species do not live in water. EISEN therefore re-united the two genera, and divided the genus thus formed into a number of subgenera on the strength of the characters afforded by the shape of the brain. MICHAELSEN has criticised EISEN'S position, pointing out that the features used by CLAPARÈDE were not the sole points of distinction between the genus *Pachydrilus* and its allies. EISEN'S criticisms were to some extent justified by reason of the fact that CLAPARÈDE placed in his genus *Pachydrilus* the species *P. lacteus*, which has white blood. This species has also, as MICHAELSEN reminded us, setae unlike those of other *Pachydrilus* in being straight, and therefore like those of the genus *Enchytraeus;* the fact that it has, like other species of *Pachydrilus*, no dorsal pores is not a reason for including it in that genus, for in many species of *Enchytraeus* these pores are wanting.

The genus *Pachydrilus* was for the first time satisfactorily defined in VEJDOVSKY'S 'Monograph of the Enchytraeidae' (p. 50); his definition is as follows:—'Borsten stark hakenförmig gebogen. Blut ockergelb oder roth. Porus cephalicus zwischen dem Kopf- und Mundlappen in der Mittellinie des Rückens. Die Segmentalorgane in allen Segmenten vorhanden, vom dritten anfangend. Hoden in büschelförmigen Gruppen, gestielt.' This definition, it will be seen, includes all the important points mentioned in MICHAELSEN'S definition, but, as a matter of fact, VEJDOVSKY applied it inaccurately when he included '*Pachydrilus*' *sphagnetorum;* this species, as was afterwards shown by MICHAELSEN, has not lobed testes (VEJDOVSKY'S specimens were immature), and has, therefore, been relegated by MICHAELSEN to another, but very nearly-related genus *Marionia*.

MICHAELSEN has argued that DRAGO'S genus *Epitelphusa* is no more than a *Pachydrilus;* it has red blood, and the testes are 'à bouquet,' two facts which

seem to be only explicable on the theory that the worm is a *Pachydrilus*. DRAGO certainly speaks of the setae as 'quasi diritte e corte'; but later says: 'Setole alquanto ricurve alle estremità.' Construing the word 'quasi' rather freely will, without any great effort, bring the genus *Epitelphusa* within the genus *Pachydrilus*.

The chief characters of the genus are given in the definition; a few of these characters, and some others, may now be stated more in detail.

One of the most characteristic structural features of the genus, though confined to a few species, is the outgrowths of the ventral nerve-chord in certain segments; these occur in *P. lineatus*, *P. maximus*, *P. nervosus*, and *P. pagenstecheri;* they were first described by EISEN (**13**).

EISEN does not do much more than briefly refer to these structures and figure them in *P. nervosus;* he remarks (p. 33), 'In *Archienchytraeus nervosus* the ganglionic swellings of the fourth and the eleventh and twelfth segments attain an enormous development, and surpass the supra-oesophageal ganglion several times in size. It is remarkable that the said swellings are found only in the segments containing the organs of generation. In *A. profugus* and *nasutus* I have sometimes found certain irregular nervous enlargements in some of the segments, but not to be compared in size with those above.'

The structures are figured (not in section) on Plate viii, fig. 16 *c* and *d*. MICHAELSEN recorded some years after a similar structure in *P.* '*germanicus*'(=*P. lineatus*); in the segments following the clitellum are lateral wing-shaped outgrowths of the nerve-chord, consisting of ganglion-cells; they are compared to somewhat similar structures found by TIMM in *Phreoryctes;* in his paper upon the Oligochaeta of South Georgia (**15**, p. 55), MICHAELSEN states that similar structures exist in *P. maximus*. In this paper these outgrowths are described in all of the three species in which they were then known to occur; they show constant, though small, differences in these three species, agreeing in their main characters in all three. They are formed as a proliferation of the ventral mass of cells of the nerve-chord; in *P. nervosus* this mass is lobate, and projects freely into the peritoneal cavity on either side of the nerve-chord, and independently of it. In the two other species they are in contact with the nerve-chord everywhere; in *P. lineatus* they approach each other dorsally.

In the region where these structures exist, the nerve-chord sends a single median nerve to the body-wall, which is accompanied by a branch from each of the lateral masses; arrived at the epidermis, the mass of nerve-fibres spreads out right and left, and the epidermis is here modified, the cells being long and spindle-shaped, without any admixture of gland-cells. This region of the epidermis

is also marked externally by a slight swelling[1]; MICHAELSEN thinks that these tracts of cells serve as sense-organs related to the generative function; the swellings are thus distributed in the three species in which they occur: in *P. maximus* in xiv, xv, xvi; in *P. lineatus* in xiii, xiv; in *P. nervosus* in xiii, xiv, xv (according to EISEN in iv, v, xii as well).

Since the investigations of MICHAELSEN, UDE (1) has recorded the discovery of the ventral organs in *P. pagenstecheri;* but no details are given, except that it is said that the organs most resemble those of *P. lineatus.* I am disposed to agree however with HESSE and to look upon these organs as copulatory glands.

MICHAELSEN allows eleven species to the genus. They are these:—

(1) *Pachydrilus lineatus,* O. F. MÜLLER.
(2) *Pachydrilus nervosus,* EISEN.
(3) *Pachydrilus profugus,* EISEN.
(4) *Pachydrilus verrucosus,* CLAPARÈDE.
(5) *Pachydrilus pagenstecheri,* RATZEL.
(6) *Pachydrilus krohnii,* CLAPARÈDE.
(7) *Pachydrilus subterraneus,* VEJDOVSKY.
(8) *Pachydrilus catanensis,* DRAGO.
(9) *Pachydrilus maximus,* MICHAELSEN.
(10) *Pachydrilus minutus,* O. F. MÜLLER.
(11) *Pachydrilus fossarum,* TAUBER.

Of these eleven, MICHAELSEN separates *P. krohnii* and *P. catanensis* as 'species inquirendae.' He also remarks, with reference to *P. fossarum,* that in the absence of further details than are given in TAUBER'S and LEVINSEN'S descriptions of this species, it cannot be regarded as certainly a 'good' species. VEJDOVSKY, however, accepts it, but without giving any reasons for so doing. Tauber's definition is this:—'Corpus, 20–40 mm. longum, postice attenuatum, ex segmentis 40–80 constans. Setae minutae, apice leviter curvatae, 4–9 in quoque fasciculo. Sanguis respiratorius purpureus. Color antice albidus, postice fuscus. Vitellus ruber. Ova mense Aprili–Junio in capsulis e stratis superioribus deciduisque clitelli formatis, multa in quaque capsula deponuntur. Variat rarior albidus.'

LEVINSEN (2, p. 231) adds to this definition that the worm has a spermatheca with a duct distinct from the main pouch, and that the duct of the nephridia comes off from the middle of the organ, and not, as is usually the case, from the extremity. That the species is really a *Pachydrilus* is evident from the facts given by TAUBER; but there is not, in my opinion, any security that LEVINSEN'S *P. fossarum* is the same species as that so named by TAUBER. If there were, the species might be regarded as distinct on account of its large size and the origin of the nephridial duct; I prefer to leave the matter as I find it. It should be mentioned that LEVINSEN considers that TAUBER'S *P. verrucosus* is identical with his *P. fossarum,* and that, according to MICHAELSEN, *P. crassus* also (of TAUBER) is the same species.

[1] Cf. *Fridericia novae-zelandiae,* and *Parenchytraeus.*

CLAPARÈDE'S *P. krohnii* is incidentally described in his memoir upon the anatomy of *Lumbricus* (1, p. 571, footnote); this worm was found in the soil near Kreuznach. It is 5–9 mm. long, and consists of about fifty segments. But CLAPARÈDE gives no other characters that are of any use in differentiating the species; it is hardly necessary to point out that the above are insufficient for this purpose.

CZERNIAVSKY has described the following species of '*Pachydrilus*':—*P. gracilis*, *P. proximus*, *P. affinis*, *P. similis*, *P. lacustris*, *P. charkoviensis*, and *P. opacus*. These are allowed by VAILLANT, who, however, does not regard the descriptions as sufficient—a conclusion which most will share with him. All these species, together with *P. cavicola* (JOSEPH), are placed by MICHAELSEN at the end of his Revision of the Enchytraeidae as 'species inquirendae.'

The well-characterized forms can be divided into two sets according to whether the spermatheca has or has not a duct distinct from the pouch.

The following table will serve to discriminate the species:—

A. Spermatheca without a duct distinct from the pouch.
- (1) Copulatory glands present.
  - (*a*) nearly covering nerve-chord . . . . **P. lineatus.**
  - (*b*) not covering nerve-chord . . . . **P. litoreus.**
- (2) No such structures.
  - (*a*) Setae, 3–5 per bundle . . . . **P. verrucosus.**
  - (*b*) Setae, 5–8 per bundle . . . . **P. subterraneus.**

B. Spermathecae with a distinct duct marked off from pouch.
- (1) Copulatory glands present.
  - i. Setae more numerous in ventral bundles . . **P. pagenstecheri.**
  - ii. Setae equal in both bundles.
    - (*a*) Copulatory glands lobed . . . . . **P. nervosus.**
    - (*b*) Copulatory glands not lobed . . . . . . **P. maximus.**
- (2) No copulatory glands.
  - i. Setae not more than 9 in a bundle . . . **P. profugus.**
  - ii. Setae as many as 14 in a bundle . . . . . . **P. minutus.**

(1) Pachydrilus nervosus, EISEN.

Archienchytraeus nervosus, EISEN, Öfv. Svensk. Akad. 1878, No. 3, p. 73.

Enchytraeus nervosus, VEJDOVSKY, Syst. u. Morph. 1884, p. 41.

Enchytraeus (Archienchytraeus) nervosus, VAILLANT, Annelés, p. 286.

Pachydrilus nervosus, MICHAELSEN, JB. Wiss. Anst. Hamb. 1888, p. 58.

Definition. *Length,* 15 *mm.; setae,* 4–7 *per bundle. Brain concave in front; outgrowths of nerve-chord large and lobed. Spermathecae with distinct demarcation between pouch and duct. Hab.—Nova Zembla.*

This species, originally described and figured in many of its details by EISEN (**13**), has been more recently studied by MICHAELSEN (**15**), who has added to EISEN'S account. The species is to be distinguished by the form of the outgrowths of the nerve-chord which are very large and lobed and do not cover the fibrous part of the chord. There seem to be no perivisceral corpuscles.

(2) Pachydrilus profugus, EISEN.

Enchytraeus pagenstecheri, EISEN, Öfv. Svensk. Akad. 1872, No. 1, p. 122.
Archienchytraeus profugus, EISEN, Öfv. Svensk. Akad. 1878, No. 3, p. 73.
Pachydrilus profugus, LEVINSEN, Vid. Med. 1883, p. 231.
Pachydrilus pagenstecheri, VEJDOVSKY, Syst. u. Morph. 1884, p. 41 (in part.).
Pachydrilus profugus, MICHAELSEN, Abh. Nat. Ver. Hamb. 1889, p. 24.

Definition. *Length,* 18 *mm.; number of segments, about* 50; *setae,* 8–9 *per bundle. Brain concave in front. Spermathecae with a distinctly marked duct rather longer than pouch and beset for its whole length with oval glands. Hab.—Greenland.*

This species, formerly confounded with *P. pagenstecheri* by EISEN, was subsequently recognized by him as distinct; the two species differ in—among other points—the characters of the setae, which in the present form are more or less uniform in size. In the definition of the species I therefore follow EISEN'S more recent description of the species; in his earlier account he gives the length as 12 mm., the number of setae as 3–9, which number suggests that, after all, some specimens at any rate of the true *P. pagenstecheri* were included.

(3) Pachydrilus verrucosus, CLAPARÈDE.

Pachydrilus verrucosus, CLAPARÈDE, Mém. Soc. Phys. Gen. 1862, p. 82.

Definition. *Length,* 12 *mm.; number of segments, about* 40; *setae,* 3–5 *per bundle; integument covered with minute papillae. Spermatheca without distinct duct. Hab.—Hebrides.*

This species has been investigated by CLAPARÈDE, who has described and figured a good many points in its anatomy; he has not, however, described the brain, or mentioned whether the spermatheca is furnished with glands as it is in other species. I include TAUBER'S *Pachydrilus verrucosus* among the synonyms, and do not relegate it, as does MICHAELSEN, to his own species *Pachydrilus fossarum;* as TAUBER merely gives the name and the locality where he met with the worm, it does not appear to me that there is any justification for doubting his identification.

(4) Pachydrilus pagenstecheri, Ratzel.

Enchytraeus pagenstecheri, Ratzel, Z. Wiss. Zool. 1868, p. 587.

Pachydrilus pagenstecheri, Vejdovsky, Ench. 1877, p. 53.

? **Enchytraeus pagenstecheri,** Tauber, Ann. Dan. p. 72.

Pachydrilus limosus, Dieffenbach, An. Syst.-Stud. 1885, p. 106.

Definition. *Length,* 15–20 *mm.; number of segments,* 55–60*; setae,* 3–5 *in dorsal,* 7–10 *in ventral bundles. Brain concave in front. Spermathecae with distinct duct twice the length of pouch, beset with glands. Hab.—Germany; Bohemia.*

This species is easily to be distinguished on account of the numbers of the setae differing in the dorsal and in the ventral bundles. Ude never found more than six setae in the ventral bundles, which appears to upset the above distinction. *Pachydrilus limosus* of Dieffenbach, which Ude identifies with *P. pagenstecheri,* has not more than five setae in a bundle. I am not at all sure that *P. limosus* is not a good species.

(5) Pachydrilus subterraneus, Vejdovsky.

Pachydrilus subterraneus, Vejdovsky, Rev. Biol. Nord, Vol. I. No. 4, p. 1.

Definition. *Length,* 20 *mm.; number of segments,* 50–55*; setae,* 5–8 *per bundle; prostomium, buccal segment, and half of the following covered with papillae. Spermathecae without distinction between pouch and duct, funnel of sperm-duct unusually long. Hab.—Prague; Lille; underground waters.*

This species has been investigated by Vejdovsky and is well characterized. It has the outward appearance of a *Tubifex* or a *Phreatothrix,* and the blood-vessels of the anterior part of the body, not specially described by Vejdovsky, are very long and coiled, contributing largely to this resemblance. A curious local peculiarity distinguishes the specimens from Lille; they have a circle of glandular cells surrounding the aperture of the spermatheca which are wanting in the individuals found in Prague; the sperm-duct funnel is extremely long reminding one of the same organ in *Marionia ebudensis;* it is represented by Vejdovsky as slightly coiled.

(6) Pachydrilus maximus, Michaelsen.

Pachydrilus maximus, Michaelsen, JB. Wiss. Anst. Hamb. 1888, p. 56.

Definition. *Length,* 40 *mm.; number of setae per bundle up to* 7*. Brain convex in front; outgrowths of nerve-chord completely cover chord laterally. Spermatheca with a short but distinct duct, surrounded at its extremity with a mass of glands. Hab.—South Georgia.*

This species is the largest, not only in the genus *Pachydrilus,* but among the

Enchytraeidae in general. The great length of the funnel (eight times as long as broad) also distinguishes this species from any of its immediate allies. It resembles, however, in this particular, *P. subterraneus*, with which it cannot be confounded, owing to other differences. The anteseptal part of nephridium is short and broad; the postseptal part is oval, with a longer duct arising from its hinder extremity. The glands of the epidermis are distinguished from those of *P. nervosus* and *P. lineatus* owing to their being deeply stained with Picrocarmine. MICHAELSEN found no giant-fibres in the nerve-chord, of which there are three in *P. lineatus*, but only one in *P. nervosus*. The dorsal vessel arises at the end of the fourteenth or fifteenth segment.

(7) Pachydrilus minutus, O. F. MÜLLER.

Lumbricus minutus, O. F. MÜLLER, Zool. Dan. Prodr., 1776, p. 216.
? **Clitellio minutus,** LÜTKEN, Revised Cat. Annel., 1884.
Pachydrilus minutus, LEVINSEN, Vid. Med., 1883, p. 231.
Clitellio minutus, VAILLANT, Annelés, p. 420.

Definition. *Length,* 14 *mm.; number of segments about* 24; *setae* 12–14 *per bundle. Spermathecae with distinct duct beset with glands. Hab.—Greenland; Denmark.*

This species would have had to be placed among the 'species inquirendae,' had it not been for LEVINSEN'S description; this rendered the distinctness of the species beyond question. Its chief character is the very large number of setae in a bundle; this, coupled with the separation between the pouch and the duct in the spermatheca enables it to be easily defined. The above synonymy is given on the authority of MICHAELSEN. VAILLANT retained the species of O. F. MÜLLER in the genus *Clitellio* in spite of the segments occupied by the clitellum. LEVINSEN does not query *Clitellio minutus* of LÜTKEN as a synonym.

(8) Pachydrilus lineatus, O. F. MÜLLER.

Lumbricus lineatus, O. F. MÜLLER, Verm. terrestr., l. ii, 1774, p. 29.
Nais littoralis var. mutica, O. F. MÜLLER, Zool. Dan., ii, 1788, p. 56.
Saenuris lineata, HOFFMEISTER, Arch. f. Nat., 1843, p. 195.
Pachydrilus rivalis, LEVINSEN, Vid. Med., 1883, p. 231.
P. germanicus, MICHAELSEN, Ench. Möb., 1886, p. 43 et passim.
P. lineatus, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 23.

Definition. *Length,* 20 *mm.; number of segments* 50; *setae,* 5–8 *per bundle. Copulatory glands nearly meet above nerve-chord. Spermathecae without distinction between pouch and duct; glands at base. Hab.—Germany; Denmark.*

MICHAELSEN gives a much longer list of synonyms than that given above; I have, however, included all of his (excepting '*Gordius pallidus linea longitudinali rufa,*' O. F. MÜLLER, excluded because not binomial) that are not queried; the principal reason which led MICHAELSEN to identify MÜLLER's species with that named by himself *P. germanicus* is the exact correspondence of locality.

(9) Pachydrilus litoreus, HESSE.

P. litoreus, HESSE, Z. wiss. Zool. 1893, p. 3.

Definition. *Length,* 17 *mm.; number of segments* 40. *Setae* 5–6 *per bundle. Copulatory glands do not meet above nerve-chord* (*in XIII–XV*). *Hab.—Naples.*

Genus MARIONIA, MICHAELSEN.

Syn. **Pachydrilus,** CLAPARÈDE (in part.).
Enchytraeoides, ROULE.

DEFINITION. Setae ſ-shaped. Head-pore between prostomium and buccal segment; no dorsal pores. Blood coloured; dorsal vessel arises behind clitellum. No salivary glands. Testes massive.

The only difference that there is between this genus and *Pachydrilus* lies in the form of the testes, which in *Marionia* are compact organs, not divided at the free extremity into several lobes, as in *Pachydrilus.* Whether this character is sufficient upon which to found a generic division is not quite certain; in the meantime, however, I adopt MICHAELSEN's opinion. The five species allowed by MICHAELSEN may be distinguished as in the table; *Marionia enchytraeoides* (=*Enchytraeoides Marionii* of ROULE) is considered by MICHAELSEN to be a 'species inquirenda.'

I. Gonads three or four segments in front of normal position . **M. sphagnetorum.**
II. Gonads normal in position.
  (1) Funnel of sperm-duct very long . . . . **M. ebudensis**[1].
  (2) Funnel not specially long.
    i. Spermathecae with a thick covering of glands at base.
      (*a*) Spermiducal glands very large . . . . . . **M. semifusca.**
      (*b*) Spermiducal glands not so large . . . . . **M. crassa.**
    ii. Glands at base of spermathecae small and few . . **M. georgiana.**

[1] This is only doubtfully a *Marionia.*

(1) Marionia sphagnetorum (VEJDOVSKY).

Pachydrilus sphagnetorum, VEJDOVSKY, SB. Böhm. Ges., 1877, p. 304.
P. (Archienchytraeus, EISEN) **sphagnetorum,** MICHAELSEN, Ench. Möb., 1886, p. 43.
M. sphagnetorum, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 29.

Definition. *Length,* 15 *mm.; number of segments* 50; *setae,* 3–4 *per bundle. Duct of nephridium long, and arising just behind septum. Gonads moved a few segments in front of usual position. Hab.—Germany.*

The examples of this species studied by VEJDOVSKY were sexually immature; but this deficiency in our knowledge of the species was filled up later by MICHAELSEN. MICHAELSEN'S observations were conducted upon what he considered to be a variety of the species to which the name '*glandulosa*' was applied, but he was able, in the same paper in which his results were described, to state that the same characters were to be found in the typical form '*sphagnetorum.*' The variety '*glandulosa*' is a stronger worm than the type-form; it measures 20 mm. as against 15; the number of setae in a bundle are two or three instead of three or four. The principal difference, however, between the two forms is in the septal glands; in the type there are five or six pairs of these glands, a pair to each segment; in the varietal form about nine pairs, owing to the fact that the duct connecting the several glands of one side of the body have given rise to additional glands. The chief character of the present species is in the abnormal position of the sexual organs, which have, as in *Buchholzia appendiculata,* been moved a few segments in advance of the normal position. They are not, however, constantly found in one particular segment; in some individuals they are three, in others four segments, in front of those which contain them in other Enchytraeids. As in the *Buchholzia* the spermathecae have preserved their normal position. The latter are composed of a very long and narrow tube, which swells out at the blind extremity into an oval pouch which does not communicate with the gut; a little way in front of the external pore (which has a mass of glands on one side) the tube has a spherical dilatation. These spermathecae are strikingly like the spermatheca of *Anachaeta bohemica* minus the terminal pouch through which the tube opens on to the exterior[1]. The funnels of the sperm-ducts are about three times as long as broad. The duct of the

[1] In a longitudinal section of the spermatheca (optical) figured by MICHAELSEN (3, Taf. xxiii, fig. 2 c) the lumen of the spherical swelling is reduced by a projection into it of a plug containing distal part of duct. This arrangement would seem to facilitate entrance of sperm into spermathecae, but to hinder its exit, at least until there is sufficient to fill the crescentic lumen of the dilatation.

spermatheca is so long that the organ often reaches back as far as the seventh segment. The lymph-corpuscles are flat, with a pear-shaped outline, subject to slight variations. This species is sexually mature in latter half of August.

(2) Marionia ebudensis (CLAPARÈDE).

Pachydrilus ebudensis, CLAPARÈDE, Mém. Soc. Phys. Gen., 1862, p. 85.
M. ebudensis, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 29.

Definition. *Length,* 12 *mm.; number of segments* 47. *Funnel of sperm-duct very long. Spermatheca hardly distinct from pouch. Hab.—Island of Skye.*

This species has been briefly characterized by CLAPARÈDE, the only naturalist who has investigated the worm. I am not quite sure that MICHAELSEN is fully justified in placing it in the present genus, rather than in *Pachydrilus.* Nothing is said by CLAPARÈDE as to the gonads, whether they are 'uniques' or 'multiples.' Indeed, one would rather infer that the testes were multiple; for, in describing the preceding species (*P. verrucosus*) CLAPARÈDE remarks that the gonads are multiple and not simple, 'comme dans les éspèces précédentes' (*M. crassa* and *M. semifusca*); it would rather seem to follow, therefore, that, in the species following, the testes were constructed on the plan of those of *P. verrucosus;* or, at the very least, the reverse could not be inferred.

(3) Marionia semifusca (CLAPARÈDE).

Pachydrilus semifuscus, CLAPARÈDE, Mém. Soc. Phys. Gen., 1862, p. 76.
M. semifusca, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 29.

Definition. *Length,* 10 *mm. Spermathecae with a duct twice as long as pouch, and with a thick coating of gland-cells at pore; spermiducal gland very large. Hab.—Island of Skye.*

This species has been imperfectly described by CLAPARÈDE; it is stated in this description that the testes are in the tenth (eleventh), and the ovaries in the twelfth (thirteenth) segment; there must be an error here, one would suppose. The funnel of the sperm-duct is hardly twice as long as broad. The spermiducal glands are so large that they occupy the whole of the coelom of their segment, and the body is even bulged out in this region. The nephridia (which are figured,

but not described), have a very short anteseptal part; the duct arises some little way behind the septum.

(4) Marionia crassa (Claparède).

Pachydrilus crassus, Claparède, Mém. Soc. Phys. Gen., 1862, p. 79.
M. crassa, Michaelsen, Abh. Nat. Ver. Hamb., 1889, p. 29.

Definition. *Length,* 15 *mm.; number of segments,* 48; *setae,* 2–5 *per bundle. Spermathecae furnished at base with minute glands. Lymph corpuscles of two different kinds. Hab.—Island of Skye.*

It seems to me to be a little doubtful whether this species is really referable to the genus *Marionia* or to *Pachydrilus.* The sharp demarcation of two kinds of lymph corpuscles is not met with elsewhere in the genus, and is used by Michaelsen to distinguish the species from other *Marionia.* Some of the cells are roundish with numerous granules, the others have the form more usual in the genus and are fusiform with no granules. Another point in which the species differs from other members of this genus or the last is in the form of the 'testes.' Claparède describes them as extending from the eighth (ninth) to the eleventh (twelfth) segment, an extent which is suggestive rather of sperm-sacs than testes. The fact that the organs in question are unpaired [1] is in favour of this suggestion. I do not pretend to speak decisively upon the matter, which requires looking into.

(5) Marionia georgiana, Michaelsen.

Pachydrilus georgianus, Michaelsen, JB. Hamb. Wiss. Anst., 1888, p. 65.
M. georgiana, Michaelsen, Abh. Nat. Ver. Hamb., 1889, p. 29.

Definition. *Length,* 8 *mm.; setae,* 5–7 *per bundle. Spermathecae with few glands at pore. Dorsal vessel springs from a cup-like depression upon intestine. Hab.—South Georgia.*

The last character in the definition distinguishes the species. The duct of the spermatheca is about half the length of the pouch. Septal glands are developed in segments iv, v, vi. The dorsal vessel originates at end of thirteenth segment.

[1] Claparède uses the singular in writing of them. But so does he in the species *M. fusca,* so that this is perhaps not quite enough reason for inferring that the organs are unpaired. d'Udekem, however, describes as 'unique,' and figures as single, the ovary of *Fridericia galba.*

Genus BUCHHOLZIA, MICHAELSEN.

Syn. **Enchytraeus,** BUCHHOLZ (in part.).

DEFINITION. Setae, ∫-shaped. Head-pore between prostomium and buccal segment; no dorsal pores. Dorsal vessel arises from the tip of a median dorsal diverticulum of the oesophagus in front of the clitellum; blood colourless. Salivary glands present.

This genus was founded by MICHAELSEN (**1**, p. 293) for the species termed by BUCHHOLZ *Enchytraeus appendiculatus*. It was defined by MICHAELSEN in the following words:—'Enchytraeiden mit farblosem Blut und leicht hakenförmig gekrümmten Borsten. Die Speicheldrüsen sind breit gelappt, mit kurzem Ausführungsgang, und münden im iv. Segment seitlich in den Oesophagus. Das Gehirn ist im Hinterrande gerade abgestützt. Der Gürtel entwickelt sich am viii. Segment und an der vordern Hälfte des ix. (schon von Buchholz der Hauptsache nach richtig angegeben). Die Samentrichter liegen vor dem Dissepiment vii/viii, und gehen, dieses Dissepiment durchbohrend, in sehr lange, feine Samenkanäle über. Die Samenkanäle münden im viii. Segment in der ventralen Borstenlinie nach aussen aus. Die Eileiter habe ich nicht erkennen können. Die Hoden bilden sich am Dissepiment vi/vii, die Ovarien am Dissepiment vii/viii. Die Samentaschen liegen im v. Segment und münden in der Intersegmentalfurche iv/v nach aussen.'

It will be noticed that in this definition the position of the reproductive organs is the main point made use of, while in the generic definition given above the position of these organs is not so much as mentioned. The discovery of a new species of the genus led MICHAELSEN to abandon the unusual position of the generative organs as a part of the necessary definition of the genus. The new species *Buchholzia fallax* agrees so closely with the type species *B. appendiculata* in all characters except the forward position of the reproductive organs that it was, as I think with reason, included by MICHAELSEN in the same genus. The main characteristic of the genus is in the single dorsal diverticulum of the oesophagus whence arises the dorsal vessel. This organ was figured and described by BUCHHOLZ (Pl. iv, fig. 2 *app.*) and led to his selecting the name of '*appendiculatus*' for the species. Later it was described and figured by VEJDOVSKY (**3**, Pl. ii, fig. 8). Both these observers noted the fact that the diverticulum was composed of a bundle of parallel tubes, of which MICHAELSEN subsequently gave a rather more detailed account in his paper upon the 'Chylusgefäss-system' of the Enchytraeidae. VEJDOVSKY regarded the tubes as blood-

vessels; MICHAELSEN pointed out that the gland is formed of a mass of glandular tubes in connection with the lumen of the gut, which are surrounded by a blood-sinus continuous on the one hand with the sinus surrounding the alimentary canal lying behind the diverticulum, and on the other hand with the dorsal vessel; the tubes appear to be intracellular, but do not seem to be ciliated; the whole gland is covered by a layer of peritoneum. In transverse sections its paired character becomes apparent, but the two halves are enclosed within one peritoneal sheath. This genus *Buchholzia* is the only genus with '*Pachydrilus*-setae' which has salivary glands; these glands are small and formed of a short duct which expands at the blind extremity into a group of oval sessile diverticula; they open some way behind the pharynx.

(1) **Buchholzia appendiculata** (BUCHHOLZ).

Enchytraeus appendiculatus, BUCHHOLZ, Schr. Phys.-Oek. Ges. Königsb. 1862, p. 93.

E. pellucidus, VEJDOVSKY, SB. Böhm. Ges. 1877, p. 301.

E. (Mesenchytraeus) appendiculatus, VEJDOVSKY, Syst. u. Morph. 1884, p. 40.

E. (Mesenchytraeus ? EISEN**) appendiculatus,** MICHAELSEN, Ench. Möb. 1886, p. 47.

B. appendiculata, MICHAELSEN, Arch. mikr. Anat. 1886, p. 293.

Definition. *Length,* 10 *mm.; number of segments, about* 35; *setae,* 3 *in lateral bundles,* 4–6 *in ventral; clitellum on VII, VIII. Testes in VII; spermathecae in V with long duct to which are appended two large glands. Hab.—Germany; Denmark; Bohemia; Italy.*

As may be inferred from the above list of references, the present species has been the subject of a considerable amount of study. It is indeed one of the best known of the Enchytraeidae. The differences which it shows from *Buchholzia fallax* will be mentioned under the description of the latter species. For its anatomy see also VEJDOVSKY (**3**), MICHAELSEN (**1**).

(2) **Buchholzia fallax,** MICHAELSEN.

B. fallax, MICHAELSEN, Arch. mikr. Anat. 1887, p. 374.

Definition. *Length,* 10 *mm.; setae,* 4–6 *per bundle of different lengths. Sexual organs occupying the usual situation; spermathecae with diverticula near to distal swollen extremity, two large glands at external pore. Hab.—Germany.*

This species has been investigated by MICHAELSEN. Its chief difference from the last species is that the sexual organs occupy the position which these organs occupy

in other Enchytraeidae, and are not moved forwards as in *Buchholzia appendiculata*. The setae of each bundle are of unequal sizes and are so arranged that the longest setae of a ventral bundle come nearest to the longest setae of a lateral bundle. The salivary glands are still more reduced than in the last species; the median dorsal diverticulum is only different from that of *B. appendiculata* in a few small points; it is not divided into two halves and the tubes are not so closely pressed together as in the former species. The spermathecae are very unusual in the peculiar character of the diverticulum; this is a canal surrounding the end of the spermatheca a little way off the end which opens into the oesophagus; this canal communicates here and there by pores with the main pouch. MICHAELSEN has also mentioned as existing in the sixth or the seventh and eighth or in the ninth segment, unpaired papilla like outgrowths of the epidermis which have the appearance of imperforate penes; the describer of the species thinks that these are not on account of their unpaired nature to be looked upon as penes; otherwise, as he points out, we can more easily understand the abnormal position of the reproductive organs in *B. appendiculata*. They appear to me to be more comparable to the genital papillae so frequently met with in the higher Oligochaeta.

Genus ENCHYTRAEUS, HENLE.

Syn. **Neoenchytraeus,** EISEN (in part.).
Archienchytraeus, MICHAELSEN, ROSA (in part.).
Pachydrilus, TAUBER (in part.).

DEFINITION. **Setae of each bundle of equal length, straight, only hooked at free extremity. Head-pore between prostomium and buccal segment. Oesophagus passing gradually into intestine. Dorsal vessel arises behind clitellum.**

The principal character of this genus is in the shape of the setae. The other characters are merely negative. It contains, according to MICHAELSEN, ten species, which are reduced to nine by UDE, who unites *E. humicultor* with *E. vejdovskii*. The species may be thus distinguished:—

I. Brain deeply cleft behind.
- i. Setae only one in each 'bundle' . . . . **E. monochaetus.**
- ii. Setae more than one in each 'bundle':
  - (1) Blood yellow . . . . **E. arenarius.**
  - (2) Blood colourless . . . . **E. spiculus.**

II. Brain convex behind or but slightly concave.

i. Funnel of sperm-duct very long . . . . **E. humicultor.**

ii. Funnel short:

(1) Spermathecae almost sessile . . . . **E. adriaticus.**

(2) Spermathecae with longish duct:

(*a*) Preseptal part of nephridium with straight duct.

Duct of spermatheca dilated . . . . . . **E. hyalinus.**

No such dilatation . . . . **E. buchholzii.**

(*b*) Preseptal part of nephridium with a convolute duct . . . . **E. argenteus.**

It will be observed that I omit LEVINSEN'S *E. affinis*, which is admitted by MICHAELSEN. This species (termed *E. danicus* by VAILLANT, on the ground of the pre-occupation of the name '*affinis*' by EISEN) is only mentioned by MICHAELSEN in his Revision to distinguish it on account of its coloured blood. It does not seem to me that MICHAELSEN is justified by the extremely slender description given by LEVINSEN in referring this species to the genus *Enchytraeus* (s. s.); no doubt, there is nothing in the description which positively forbids this identification; the species, in all probability is referable either to this genus or to *Fridericia;* but why not to the latter? LEVINSEN does not mention the dorsal pores, but neither does he in the case of '*Enchytraeus*' *bisetosus*, placed by MICHAELSEN in the genus *Fridericia.* The most remarkable fact about the species is the presence of 'chlorophyll corpuscles' in the integument. Concerning these further information is to be desired.

'*Enchytraeus*' *minutus* of TAUBER may or may not belong to this genus. It is not referred to by MICHAELSEN. It is, if an Enchytraeid, the minutest species, measuring only 0·1 mm.; the setae are paired (cf. *Fridericia bisetosa*): 'Semen vivum in segmento quarto, ova in quinto sextoque.' This does not seem intelligible on the theory that the worm is of this family.

(1) Enchytraeus humicultor, VEJDOVSKY.

Enchytraeus humicultor, VEJDOVSKY, Ench., 1879, p. 57.

E. spiculus, MÖBIUS, JB. Comm. wiss. Unt. deutsch. Meer., 1873, p. 107 (in part.).

Neoenchytraeus vejdovskii, EISEN, Öfv. Svensk. Akad., 1878, No. 3, p. 75.

N. Stuxbergi, EISEN, ibid., p. 75.

Pachydrilus lacteus, TAUBER, Ann. Dan., 1879, p. 71.

E. fucorum, LEVINSEN, Vid. Med., 1883, p. 235.

E. sordidus, LEVINSEN, ibid., p. 235.

E. vejdovskii, VEJDOVSKY, Syst. u. Morph., 1884, p. 41.

E. Stuxbergi, VEJDOVSKY, ibid., p. 41.

Archienchytraeus möbii, MICHAELSEN, Zool. Anz., 1885, p. 237.

E. möbii, MICHAELSEN, Ench. Möb., 1886, p. 1 [1].

[1] To the above list of synonyms should possibly be added *E. vermicularis* of TAUBER (in part.), which LEVINSEN identifies with his *E. sordidus*.

Definition. *Length, 35 mm.; number of segments, 74; setae, 3–5 (rarely 6) per bundle. Brain slightly concave behind. Nephridia with only funnel anteseptal. Sperm-duct funnels very long; duct of spermatheca as long as, and sharply marked off from, pouch, and beset with glands along entire length. Hab.—Nova Zembla; Siberia; Denmark; Germany. Sea-shore.*

The above list of synonyms is adopted on the authority of MICHAELSEN, and *E. humicultor* is added on that of UDE; the name, therefore, of the species must be altered from *E. vejdovskii* to *E. humicultor.* MICHAELSEN'S identification of six differently named species with *E. vejdovskii* depends, not on a mere collating of the various descriptions given, but upon an examination of most of the types; it is clear, therefore, that there is no choice but to follow him. EISEN has stated that *E. stuxbergi* has red-coloured blood; but, as MICHAELSEN has pointed out, this apparent difference from *E. möbii*, &c., is not to be regarded, as the worm was not examined in the fresh condition. Moreover, half of the material labelled by EISEN *E. stuxbergi* is really made up of specimens of *Pachydrilus nervosus*, which, of course, *has* red blood. As for the two species described by LEVINSEN, and referred to this species, I do not gather that MICHAELSEN examined type-specimens; the synonym, *P. lacteus* of TAUBER, I understand MICHAELSEN to have introduced on the authority of LEVINSEN. The chief reason for believing in the identity of *E. sordidus* and *E. fucorum* with *E. vejdovskii*, &c., appears to be in the similarity of the spermathecae with their continuous coating of gland-cells upon the duct. The sole difference between VEJDOVSKY'S *E. humicultor* and *E. vejdovskii* is in the presence in the former of dorsal pores; UDE, who considers these species to be the same, points out that the presence of these pores requires verification. They are, however, figured by VEJDOVSKY (**3**, Pl. v, fig. 6). I may mention another small difference; MICHAELSEN, in his account of the anatomy of '*Enchytraeus möbii*' (the most complete account of the species), states that the dorsal vessel springs from the blood-sinus of the intestine in the fifteenth segment, and that it is dilated in this and the two segments lying in front into hearts. On the other hand, VEJDOVSKY described and figured the dorsal vessel as arising in the seventeenth segment, and the hearts as lying in segments xvi, xv, xiv. UDE has neglected this point, which, however, may not be a serious matter of difference. In other respects the two species undoubtedly agree.

E. humicultor has the same long sperm-duct funnel, and the duct of the spermatheca is, in the same way as in '*E. möbii*,' &c., beset with glands along its whole course; the nephridia in every case have an anteseptal portion, which consists only of the funnel. Between the male-pores is an area of the clitellum devoid of glandular modification. Four perivisceral trunks connect dorsal and ventral vessel, of which the two middle pairs belong to the fourth segment.

(2) Enchytraeus spiculus, FREY and LEUCKART.

E. spiculus, FREY and LEUCKART, Beitr. Kennt. wirbell. Th., 1847, p. 150.

E. ? spiculus, TAUBER, Ann. Dan., 1879, p. 73.

Definition. *Length, 10 mm.; number of segments about 30; setae 4–6 (rarely 8) per bundle. Anteseptal portion of nephridium with straight duct. Brain deeply cleft behind. Hab.—Heligoland; Cuxhaven; Wilhelmshaven.*

This species has been principally investigated by MICHAELSEN (**13**).

It does not, however, seem to be by any means certain that the species termed by MICHAELSEN '*spiculus*' are the same as the *E. spiculus* of LEUCKART. VEJDOVSKY places this species among the 'species inquirendae,' and VAILLANT (**6**, p. 247) remarks that 'il est assez difficile de pouvoir apprécier la valeur des *E. spiculus*, &c.' emphasizing this remark by relegating the species to the section 'incertae sedis' on p. 253 of his work.

If MICHAELSEN'S identification be right, the species can easily be distinguished from others; as a general rule there are not more than six setae in a bundle, but occasionally the number is as high as eight. The spermathecae consist of a pear-shaped pouch, communicating with the exterior by means of a rather short, straight, simple duct. The nephridia are straight, or bent sharply at right angles; there is no constriction at the septum; there is no distinctly differentiated duct leading to the exterior, the calibre of the organ diminishing but slightly at the point where it comes into contact with body-wall; the anteseptal part of the organ, besides the characters mentioned in the definition of the species, is to be distinguished by the absence of granules, and is, therefore, quite clear. The clitellum is remarkable for the fact that there are regularly alternating transverse lines of darkly-staining and hardly-staining cells. A curious point about the species appears to be that the cocoons contain only one egg, differing, therefore, from all the other marine Enchytraeidae.

(3) **Enchytraeus buchholzii,** VEJDOVSKY.

E. buchholzii, VEJDOVSKY, SB. Böhm. Ges. 1877, p. 302.

Archienchytraeus Bucholzii, ROSA, Boll. Mus. Zool. Torino, 1887, No. 29.

Definition. *Length,* 10 *mm.; number of segments,* 28 *; setae,* 2–3 *per bundle. Brain slightly concave behind. Nephridia with narrow anteseptal portion, with straight lumen, no differentiated duct. Spermathecae with duct as long as pouch, a group of glands at pore. Hab.—Denmark; Germany; Bohemia; Italy.*

This species has been chiefly studied by VEJDOVSKY and by UDE (**1**). The salivary glands are long and much coiled in the distal half; these organs are figured by VEJDOVSKY (**3**, Pl. iii. fig. 1) as gradually diminishing in calibre towards the free end, but UDE found that, in all the examples of the species examined by himself, the coiled part of the gland arose from a broad tract. The funnels of the sperm-ducts are not large; the duct is composed of comparatively few coils, and the spermiducal glands at its termination are large.

(4) **Enchytraeus adriaticus,** VEJDOVSKY.

E. adriaticus, VEJDOVSKY, SB. Böhm. Ges., 1877, p. 302.

E. adriaticus (forma jaltensis), CZERNIAVSKY, Bull. Soc. Nat. Mosc., 1880, p. 322.

Definition. *Length, 15 mm.; number of segments, 25; setae, 3 per bundle. Brain convex posteriorly. Anteseptal part of nephridium hardly narrower than postseptal, with coiled lumen. Spermatheca with short duct covered by three rows of glandular cells. Hab.—Austro-Illyrian coast-line; Jalta.*

(5) **Enchytraeus monochaetus,** MICHAELSEN.

E. monochaetus, MICHAELSEN, JB. wiss. Anst. Hamb. 1888, p. 66.

Definition. *Length, 7 mm.; setae in four rows of a single seta each; setae usually wanting upon the first four or five segments, lateral setae wanting upon a few segments after. No salivary glands. Brain deeply cleft behind. Nephridia bent at right angles, anteseptal part not much more than funnel, duct not sharply marked off. Spermathecae with a long duct as long as, and sharply distinguished from, the pear-shaped pouch, a few glands at base. Hab.—South Georgia, sea-shore.*

This species is most remarkable for the 'cephalization,' met with in no other Enchytraeid. MICHAELSEN states that the cuticle is unusually thick. In the buccal cavity is a taste-papilla. Besides the other characters mentioned in the above definition, the species has one pair of small septal glands in the fourth segment, two pairs of larger glands in the fifth segment, and three pairs of very large ones in the sixth segment; the sperm-duct funnel is short.

(6) **Enchytraeus arenarius,** MICHAELSEN.

E. arenarius, MICHAELSEN, ibid. 1889, p. 12.

Definition. *Length, 10 mm.; setae, 3 per bundle. Brain deeply cleft behind. Anteseptal part of nephridia little more than funnel, duct arises near to septum as in* Mesenchytraeus. *Spermathecae cylindrical with no distinction between pouch and duct, external pore with glandular cells. Hab.—Germany (Elbe shore).*

MICHAELSEN describes as a remarkable character of this species the form of the perivisceral corpuscles; these are furnished along one side with numerous pointed processes. The blood, moreover, is yellow—the present species being the only one of the genus which shows this *Pachydrilus*-like character, if we except

the doubtful species *E. affinis*. This resemblance to *Pachydrilus* is further increased by the fact that the ventral nerve-chord has outgrowths such as those which occur in *P. nervosus* (see p. 323), which are found in the first post-clitellian segments. The nephridia are peculiar in the points mentioned in the definition; besides these, MICHAELSEN figures (fig. 5 *c*) a transparent sheath covering the dorsal aspect of the post-septal part of the organs. The funnels of the sperm-ducts are longer than in any other *Enchytraeus;* the proportion of length to breadth is about 12 : 1.

(7) Enchytraeus argenteus, MICHAELSEN.

E. argenteus, MICHAELSEN, ibid. p. 15.

Definition. *Length,* 5 *mm.; number of segments,* 30*; setae,* 2–3 *per bundle. Brain convex behind. Anteseptal part of nephridia of equal diameter with postseptal part, containing also a coiled lumen, duct comes off at right angles, and is long and distinct. Hab.—Germany (Elbe shore).*

This species appears to be the smallest of the Enchytraeidae. The name of the species was given to it on account of its silver colour, due to the dark pigmentation of the perivisceral corpuscles.

(8) Enchytraeus hyalinus (EISEN).

Neoenchytraeus hyalinus, EISEN, Öfv. Svensk. Akad., 1878, No. 3, p. 76.
E. hyalinus, VEJDOVSKY, Syst. u. Morph., 1884, p. 41.
E. (Neoenchytraeus) hyalinus, VAILLANT, Annelés, p. 264.

Definition. *Length,* 8 *mm.; number of segments* 43*; setae,* 3 *per bundle. Brain convex behind. Anteseptal part of nephridium long, with nearly straight duct. Spermathecae with a dilatation upon the duct, at opening of which are a few glands. Hab.—Nova Zembla.*

MICHAELSEN (**5**, p. 40) distinguishes this species from *E. adriaticus* by the presence in the latter of numerous small pear-shaped glands; I do not think that this difference will hold; EISEN figures (**13**, Pl. x, fig. 201) quite similar glands in *E. hyalinus*. I do not perfectly understand the shape of the spermathecae from EISEN's figures; he describes the spermatheca as consisting 'of two distinct parts, the lower one is funnel-shaped and wrinkled, and furnished at the base with small glands,' &c. I suppose that merely a dilatation of the duct is meant such as occurs in the species.

Genus **FRIDERICIA**, MICHAELSEN.

Syn. **Enchytraeus,** AUCT. (in part.).
Neoenchytraeus, EISEN (in part.).

DEFINITION. **Setae straight, either two to a bundle or more, in which case the middle setae are much smaller. Head-pore between prostomium and buccal segment, dorsal pores also present. Salivary glands always present. Dorsal vessel springs in nearly every case behind the clitellum; blood colourless. Spermathecae, as a rule, with appendices. Copulatory glands sometimes present.**

If it is a little difficult to define *Enchytraeus* (s. s.) there can be no difficulty in distinguishing the present genus. The most conspicuous character is undoubtedly the presence of dorsal pores, which are not found elsewhere among the Enchytraeidae, save only in the doubtful (according to UDE) instance of *Enchytraeus humicultor*. Another matter in which the genus is peculiar concerns the setae; these are developed in each bundle two at a time; the next youngest pair lie within the first-formed, the following within these, &c.; the result is that, in a bundle, the two outermost setae are the oldest and longest, the innermost the youngest and shortest; sometimes the symmetry of the arrangement is spoiled by one seta falling out; in the species *F. bisetosa* it appears that the older pair falls out before the next is developed; hence this worm has two setae only in each bundle. This remarkable and interesting mode of development of the setae in Enchytraeids was first made known by VEJDOVSKY in his work upon the Enchytraeidae (**3**).

MICHAELSEN allows eleven species[1] of *Fridericia*, to which may be added my species *F. antarctica*, which may be distinguished from each other by the following table:—

I. Spermathecae without diverticula.

i. Salivary glands branched . . . . **F. striata.**

ii. Salivary glands not branched . . . . **F. bulbosa.**

[1] *Enchytraeus vermicularis* of CLAPARÈDE (3, p. 55) seems to be undoubtedly a *Fridericia*, since it has dorsal pores (3, Pl. ii. figs. 10, 11). The absence of diverticula to the spermathecae ('les réceptacles de la semence . . . ressemblent beaucoup à ceux du *Pachydrilus semifuscus*') places the species in the neighbourhood of *F. striata* and *F. bulbosa*, from both of which it differs in that the anteseptal part of the nephridium is long, but has a straight duct.

II. Spermathecae with diverticula.

i. Anteseptal part of nephridium no more than funnel.

(1) Diverticula of spermatheca two . . . . **F. leydigii.**

(2) Diverticula very numerous . . . . **F. hegemon.**

ii. Anteseptal region large, with coiled duct.

(1) Glands at base of spermathecae.

(*a*) One large gland. . . . . **F. dura.**

(*b*) Several glands . . . . **F. ratzelii.**

(2) No glands at base of spermathecae.

(*a*) Diverticula in the form of solid glands . . . **F. lobifera.**

(*b*) Diverticula hardly developed . . . . **F. callosa.**

(*c*) Two diverticula.

(α) Setae paired . . . . **F. bisetosa.**

(β) Setae 4–6 . . . . **F. perrieri.**

(*d*) Four diverticula. . . . . **F. galba.**

(*e*) Seven diverticula . . . . **F. antarctica.**

In two species of the genus the spermathecae are simple, without diverticula; in all the others these diverticula are present, and sometimes (in *F. hegemon*, for example) extremely numerous. This recalls the peculiar ring, with occasional openings into the spermatheca, which surrounds the spermathecae of *Buchholzia fallax.* The dorsal pores commence in the seventh ring; the perivisceral corpuscles are of two kinds; the larger are circular or more or less elliptical, the smaller *Navicella*-shaped.

(1) Fridericia striata (Levinsen).

Enchytraeus striatus, Levinsen, Vid. Med., 1883, p. 236.

F. striata, Michaelsen, Abh. Nat. Ver. Hamb., 1889, p. 42.

Definition. *Length,* 10·5 *mm.; number of segments* 50; *setae,* 6–8 *per bundle. Nephridia with large anteseptal part, in which lumen is coiled. Spermathecae without diverticula. Hab.—Denmark; Germany.*

This species has been described by Levinsen and by Ude (**1**). The former says that there are sometimes nine setae in a segment; this must result from the dropping out of a tenth; I give eight as the highest number in accordance with Ude's statements. Sometimes, however, there are only four setae to a bundle; in this case the inner pair are about one-third shorter than the outer. The colour of the species (a greenish-grey) is said by Levinsen to be due to the presence of chlorophyll

bodies in the skin; the same author has mentioned a similar presence of chlorophyll in *Enchytraeus affinis* [1]. The brain is described by UDE as longer than broad, with a slight convex hinder margin; the dorsal vessel arises behind the clitellum in the sixteenth segment. The funnels of the sperm-ducts are 2–3 times as long as broad; the prostates are large. The salivary glands are branched at the extremity.

(2) Fridericia bulbosa (ROSA).

Neoenchytraeus bulbosus, ROSA, Boll. Mus. Zool. Torino, 1887, No. 29.
F. bulbosa, MICHAELSEN, Abh. Nat. Ver. Hamb. 1889, p. 42.

Definition. *Length, 8 mm.; number of segments, 42; setae, 4 per bundle in anterior segments, 2 posteriorly. Lumen of anteseptal part of nephridia short, wide, and straight. Spermathecae without diverticulum, duct about twice the length of pouch, with glands at base. Hab.—Italy; Germany.*

This species has been described by both ROSA and UDE (**1**); their accounts differ in some small particulars, which possibly are indicative of geographical varieties. Thus ROSA speaks of the salivary glands as slightly branched, generally only bifurcate, while UDE says that they are simple and not branched. ROSA found no glands upon the spermathecal duct, which are stated by UDE to be present. The brain is said by ROSA to be rounded behind, by UDE to be slightly concave; this difference is in all probability to be set down to the different degrees of contraction of the cerebral muscles. The funnels of the sperm-ducts are three times as long as broad, their ducts are furnished with large spermiducal glands (UDE).

(3) Fridericia callosa (EISEN).

Neoenchytraeus callosus, EISEN, Öfv. Svensk. Akad., 1878, No. 3, p. 76.
Enchytraeus callosus, VEJDOVSKY, Syst. u. Morph., 1884, p. 41.
F. callosa, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 42.

Definition. *Length, 20 mm.; number of segments 64 (about); setae, 4 in a bundle. Anteseptal part of nephridium short, with straight duct; duct leading to exterior comes off just behind septum. Spermathecae with three indistinct diverticula. Hab.—Nova Zembla.*

Our knowledge of this species, originally due to EISEN, has been supplemented by MICHAELSEN. The anterior as well as the posterior margin of the brain is convex; the length of the brain is about a quarter greater than its breadth. The

[1] See description of *Anachaeta*, where chlorophyll does occur.

spermathecae are intermediate in their characters between those of the simpler forms without any diverticulum and the more differentiated species; the pouch swells out at the base into three compartments, which are not constricted off from the main chamber.

(4) Fridericia bisetosa (Levinsen).

Enchytraeus bisetosus, Levinsen, Vid. Med., 1883, p. 233.
E. (Mesenchytraeus) bisetosus, Vaillant, Annelés, p. 268.
E. (Neoenchytraeus, Eisen) **Leydigii,** Michaelsen, Ench. Möb., 1886, p. 47.
E. tenuis, Michaelsen, Arch. Mikr. Anat., 1886, p. 294.
Neoenchytraeus bisetosus, Rosa, Boll. Mus. Zool. Torino, 1887, No. 29.
F. bisetosa, Michaelsen, Abh. Nat. Ver. Hamb., 1889, p. 43.

Definition. *Length,* 20 *mm.; number of segments,* 60*; setae, paired. Anteseptal region of nephridium nearly equal to postseptal, with undulating duct. Spermathecae with two diverticula. Hab.—Denmark; Germany; Italy.*

It does not appear to be quite certain whether Michaelsen's '*Enchytraeus tenuis*' is really identical with Levinsen's '*Enchytraeus setosus*'; Michaelsen himself, in a paper subsequent to that in which the species was described, considered that the question of the identity of the species was not settled; the principal difficulty in the way of uniting them was the fact that in the supposed species '*tenuis*' the anteseptal part of the nephridium was not equal in extent to the postseptal. Ude commented upon differences in the form of the diverticula of the spermathecae, and the form of the funnel of the efferent duct. In the meantime I retain here the view expressed in Michaelsen's paper, viz. the identity of the species.

The species is characterized by the fact that there are, as a rule, but two setae to each bundle; this is, however, not invariably the case; four were found by Ude in immature individuals, one pair of which were, however, evidently just on the point of falling out. The brain is about double as long as broad, with a nearly straight or slightly concave hinder margin (convex in '*tenuis*'). The dorsal vessel arises in the eighteenth segment; the salivary glands are slightly branched; the funnel of the male efferent duct is double as long as broad; the ducts themselves are long and coiled; the spermiducal glands are large.

(5) Fridericia leydigii (Vejdovsky).

Enchytraeus Leydigii, Vejdovsky, SB. Böhm. Ges., 1877, p. 303.
E. (Neoenchytraeus) Leydigii, Vaillant, Annelés, p. 255.
Neoenchytraeus Leydigii, Rosa, Boll. Mus. Zool. Torino, 1887, No. 29.
F. Leydigii, Michaelsen, Abh. Nat. Ver. Hamb., 1889, p. 43.

Definition. *Length,* 12 *mm.; number of segments,* 45; *setae,* 2–4 *per bundle. Anteseptal part of nephridia not large, but with a convoluted duct, and covered with brown pigment. Spermathecae with two large diverticula, without glands at base. Hab.—Bohemia; Italy.*

The brain of this species is nearly twice as long as broad, with a convex posterior margin; the salivary glands are sparely branched. The funnel of the male efferent duct is about three times as long as broad; the ducts themselves very long and thin; there are spermiducal glands, but VEJDOVSKY has given no details as to their size, &c. This species is not identical with MICHAELSEN'S (**4**, p. 47) *Enchytraeus leydigii* (for which see above, p. 344).

(6) **Fridericia perrieri** (VEJDOVSKY).

Enchytraeus Perrieri, VEJDOVSKY, SB. Böhm. Ges., 1877, p. 302.
E. (**Neoenchytraeus**) **Perrieri,** VAILLANT, Annelés, p. 256.
Neoenchytraeus Perrieri, ROSA, Boll. Mus. Zool. Torino, 1887, No. 29.
? **E.** (**Neoenchytraeus,** EISEN) **Perrieri,** MICHAELSEN, Ench. Möb., 1886, p. 47.
Fridericia Perrieri, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 43.

Definition. *Length,* 15 *mm.; number of segments,* 58; *setae,* 4–6 *per bundle, more numerous in ventral bundles. Anteseptal part of nephridium long and narrow, but with contorted duct. Spermathecae with two diverticula, dilated at their blind extremity. Salivary glands with two whorls of branches. Hab.—Denmark; Germany; Italy. Terrestrial.*

This is a very marked species, on account of the peculiar arrangement of the branches of the salivary glands; these branches form two sets, which are inserted on to the duct of the organ at the same level, in segments iv, v; another remarkable character of the species is in the presence of dilatations of the dorsal vessel in segments v, vi, and vii; this suggests, as MICHAELSEN has pointed out, that the dorsal vessel is ante-clitellian in origin, since such swellings seem to be invariably found at the commencement of the dorsal vessel. VEJDOVSKY'S figure of the male efferent organs (**3** Pl. viii. fig. 9) looks as if there were no spermiducal glands; he figures a number of strands which suggest retractor muscles attached to the integument round the external orifice of the duct. These important differences from other species of *Fridericia* almost seem to necessitate the creation of a new genus. The brain is convex behind; it is nearly twice as long as broad. There are three perivisceral trunks uniting the dorsal and ventral vessels; the two anterior of these spring from a common trunk, which is very short.

(7) Fridericia galba (Hoffmeister).

Enchytraeus Galba, Hoffmeister, Arch. f. Nat., 1843, p. 194 (in part.).
E. galber,[1] d'Udekem, Bull. Ac. Roy. Belg., xxii. pt. ii. 1855, p. 547.
E. (Neoenchytraeus, Eisen) **galba,** Michaelsen, Ench. Möb., 1886, p. 48.
E. vermicularis, Ratzel, Z. wiss. Zool., 1868, p. 588 (in part.).
Neoenchytraeus galba, Rosa, Boll. Mus. Zool. Torino, 1887, No. 29.
Fridericia galba, Michaelsen, Abh. Nat. Ver. Hamb., 1889, p. 43.

Definition. *Length,* 20 *mm.; number of segments,* 50; *setae,* 4–6 *per bundle, at posterior end all setae of a bundle equally long. Anteseptal part of nephridia long and broad, with contorted duct. Spermathecae with four stalked diverticula. Hab.—Denmark; Germany; Belgium; Bohemia; Italy.*

This species has been much studied in comparison to many others; see d'Udekem (**4**), Leydig (**2**), Buchholz, Vejdovsky (**3**).

The identity of Ratzel's *E. vermicularis* in part with Hoffmeister's *E. galba* is stated by Ratzel in a later paper (**1**, p. 28, footnote). Michaelsen queries the identity of Tauber's *E. galba* with the species so called by Hoffmeister and others; as, however, Tauber contents himself with a mere mention of the occurrence of the species, it is difficult to see why this should be called in question unless from a general distrust of Tauber's identifications.

The brain is double as long as broad, with a slightly convex hinder margin. The salivary glands are branched posteriorly. The funnel of the sperm-duct is four times as long as broad; the duct is long and coiled, and there are large spermiducal glands. The diverticula of the spermathecae appear to vary in number from four to six[2]. There appear to be no glands at the external pore.

Vejdovsky was of opinion (**3**, p. 5) that Hoffmeister's '*E. galba*' included all the larger Enchytraeids. It must be admitted that Hoffmeister's definition is totally insufficient to characterize the species as we now know it.

(8) Fridericia lobifera (Vejdovsky).

Enchytraeus lobifer, Vejdovsky, Ench., 1879, p. 57.
E. (Archienchytraeus) lobifer, Vaillant, Annelés, p. 279.
Fridericia lobifera, Michaelsen, Abh. Nat. Ver. Hamb., 1889, p. 44.

Definition. *Length,* 20 *mm.; number of segments,* 60; *setae in anterior region of body* 4, *in*

[1] Of course a misprint, with which, it may be remarked, that particular paper teems.
[2] 4–8 according to Levinsen. d'Udekem also (**4**, Pl. iii. fig. 8) figures eight.

ventral 6, *in dorsal bundles, in posterior region* 2. *Aanteseptal part of nephridium short, with brown pigment. Spermathecae with numerous diverticula, which are solid. Hab.—Bohemia.*

This species is to be easily known by the fact that the diverticula of the spermathecae, or, to speak more accurately, the appendages of that organ, which appear to correspond to the diverticula of other species, are solid, and probably (MICHAELSEN) function as glands. The brain is concave behind. The salivary glands are provided with numerous branches. The duct of the nephridium arises just behind the septum; VEJDOVSKY does not state whether the anteseptal part of that organ has a straight or contorted lumen.

(9) Fridericia ratzeli (EISEN).

Enchytraeus Ratzeli, EISEN, Öfv. Svensk. Akad., 1872, No. 1, p. 123.
Neoenchytraeus Ratzelii, EISEN, Öfv. Svensk. Akad., 1878, No. 3, p. 77.
E. Ratzelii, LEVINSEN, Vid. Med., 1883, p. 237.
E. (Neoenchytraeus) Ratzelii, VAILLANT, Annelés, p. 262.
Fridericia Ratzelii, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 44.

Definition. *Length,* 30 *mm.; number of segments,* 60; *setae,* 6–8 *anteriorly,* 4 *posteriorly. Anteseptal part of nephridia narrow, but with contorted duct; its duct arises just behind septum. Spermathecae with* 6–12 *diverticula, with a few small glands at base of duct. Hab.—Norway; Germany; Italy.*

The brain has a convex hinder margin. The salivary glands are branched. UDE states that at the external pore of the spermathecae are two large stalked glands instead of the numerous small glands figured (Pl. xii. fig. xxii *c*) by EISEN. LEVINSEN, on the other hand, says: 'Recept. seminis ved Udmundigen uden stilket Kjertelmasse.' For structure see, in addition to above references UDE (**1**), EISEN (**13**), and HESSE, who describes 'copulatory glands' like those of *F. antarctica* in the thirteenth segment.

(10) Fridericia dura (EISEN).

Neoenchytraeus durus, EISEN, Öfv. Svensk. Akad., 1878, No. 3, p. 77.
Enchytraeus durus, VEJDOVSKY, Syst. u. Morph., 1884, p. 41.
E. (Neoenchytraeus) durus, VAILLANT, Annelés, p. 263.
Fridericia dura, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 44.

Definition. *Length,* 16 *mm.; number of segments,* 45 (*about*); *setae,* 6 *per bundle. Anteseptal*

part of nephridium long and stout with coiled duct, duct of nephridium arising just behind septum. Spermathecae with many diverticula, at base of duct one large gland (or many small glands). Hab.—Norway.

This species is very nearly akin to the last; it is, indeed, a matter of no little difficulty to distinguish them by the descriptions given. MICHAELSEN distinguishes them by the 'absence' of any glands at the external pore of the spermatheca in *F. ratzeli*, these structures being present in *F. dura*. EISEN, however, figures a few small glands in this position in *F. ratzeli* (Pl. xii. fig. 22 *c*). This point is still further confused by UDE'S statement that *F. ratzeli* has two stalked glands instead of the many figured by EISEN. Another point of difference urged by MICHAELSEN is that the brain of *F. dura* is triangular, while that of *F. ratzeli* is oval, and longer than broad. The number of setae also is greater in *F. ratzeli*. If the supposed difference in the brains has no existence, it will, I think, be necessary to unite the two species.

This species, like *F. ratzeli*, *F. callosa*, and *E. hegemon*, has a double layer of longitudinal muscles. The salivary glands are stated by MICHAELSEN to be like those of *F. callosa*.

(11) **Fridericia hegemon** (VEJDOVSKY).

Enchytraeus hegemon, VEJDOVSKY, SB. Böhm. Ges., 1877, p. 303.
E. (Neoenchytraeus) hegemon, VAILLANT, Annelés, p. 257.
Fridericia hegemon, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 44.

Definition. *Length, 30 mm.; setae, 4 per bundle. Anteseptal part of nephridium short, with straight duct. Spermathecae very numerous with stalked diverticula, with a pair of large glands at external pore. Hab.—Bohemia; Germany. Terrestrial.*

This species is very distinct from any other; its chief characteristic is the very numerous stalked diverticula. The species has been studied by VEJDOVSKY (**3**) and MICHAELSEN (**4**). The brain is oval in contour, with a marked projection anteriorly, and is convex posteriorly. The salivary glands are much branched—more so than in any other *Fridericia*. The dorsal blood-vessel springs from the peri-intestinal sinus in the eighteenth segment; in this segment, and in the seventeenth, sixteenth, fifteenth, fourteenth, are heart-like swellings which are also developed, though to a less extent, in the two segments lying in front of these again. There is an organ of taste in the buccal cavity similar to that of other species of Enchytraeids.

(12) **Fridericia antarctica**, Beddard.

Fridericia antarctica, Beddard, Proc. Roy. Phys. Soc., 1892–93, p. 41.

Definition. *Length*, 18 *mm.; number of segments*, 63*; setae*, 4–6 *per bundle. Anteseptal part of nephridium as large as postseptal, with convoluted duct. Spermatheca with numerous diverticula. On segments XIII–XV papillae connected with peculiar cells surrounding nerve-chord. Hab.—New Zealand.*

This species, though agreeing in most of its characters with *F. galba*, is apparently to be distinguished by masses of cells surrounding the nerve-chord in certain segments which appear to be comparable to those of *F. ratzeli* and *Pachydrilus* (see p. 323). The cells in question are large, pear-shaped, and granular; they have, indeed, a glandular, rather than a nervous, look; but, being enclosed in a common sheath with the nerve-chord, favours their nervous nature.

The clitellum occupies segments xi–xiii, and is developed all round the body. The setae of xii are, as usual, absent. The salivary glands are branched. The septal glands occupy iv–vii, and the intestine commences in xiv. The sperm-duct funnel is three times as long as broad.

Genus **HENLEA**, Michaelsen.

Syn. **Enchytraeus**, d'Udekem et alii (in part.).
Archienchytraeus, Eisen (in part.).

Definition. Setae different in form and arrangement, according to the species. Head-pore between prostomium and buccal segment; no dorsal pores. Oesophagus sharply marked off from the intestine. Dorsal vessel arises in front of the clitellum; blood colourless. Duct of nephridium springs from the postseptal portion near to the septum.

This genus has been recently instituted by Michaelsen in his Synopsis of the family (5). It forms undoubtedly a somewhat heterogeneous assemblage of species, which are chiefly bound together by the fact that the oesophagus is distinctly separated from the intestine by a constriction, and by the ante-clitellian origin of the dorsal vessel; as a rule, there are oesophageal glands at the commencement of the intestine; all these points ally the genus *Henlea* to the genus *Buchholzia.* There appear to be no other characters distinctive of the genus; some have and some have not salivary glands; *H. puteana* has two pairs of spermathecae, which

is unique in the whole family; this species also has straight setae like those of the genus *Enchytraeus*, while in *H. dicksonii* the setae are ſ-shaped, as in the genus *Pachydrilus*, &c. The following species, at least, appear to be well characterized:—

(1) **Henlea ventriculosa.**

(2) **Henlea leptodera.**

(3) **Henlea puteana.**

Besides these three, MICHAELSEN has assigned three others to the genus: viz. *H. socialis*, *H. nasuta*, and *H. dicksonii*. The latter has been investigated by EISEN and by MICHAELSEN; more recently, UDE has added something to our knowledge of this species, which may be now removed from the doubtful position it held at the time that MICHAELSEN wrote.

'*Enchytraeus socialis*' of LEIDY (6) is queried as a member of the genus *Enchytraeus* by VAILLANT (6, p. 291); but it must, of course, be remembered that *Enchytraeus*, with that naturalist, is used in a very wide sense.

The only salient point in the description of the species is that it possesses a dilatation upon the oesophagus in the eighth segment, a fact which led MICHAELSEN to place it in the present genus. No more than this can be said.

The well-known species can be distinguished by the following table:—

I. Two pairs of spermathecae	**H. puteana.**
II. One pair of spermathecae.	
(1) No oesophageal glands	**H. dicksonii.**
(2) Two oesophageal glands	**H. leptodera.**
(3) Four oesophageal glands	**H. ventriculosa.**

(1) Henlea ventriculosa (D'UDEKEM).

Enchytraeus ventriculosus, D'UDEKEM, Bull. Ac. Roy. Belg., 1855, xxii. pt. ii. p. 547.

E. latus, LEYDIG, Vom Bau des thierischen Körpers, 1864 (Fide MICHAELSEN).

E. (Archienchytraeus, EISEN) ventriculosus, MICHAELSEN, Ench. Möb., 1886, p. 46.

E. (Archienchytraeus) albidus, VAILLANT, Annelés, p. 281 (in part.).

Archienchytraeus ventriculosus, ROSA, Boll. Mus. Zool. Torino, 1887, No. 29.

Henlea ventriculosa, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 31.

Definition. *Length*, 15–20 *mm.; number of segments*, 60; *setae straight or slightly bent to right or left*, 4–9. *Four oesophageal glands. Hab.—Germany; Denmark; Bohemia; Italy; Belgium; New Zealand; Asia. Terrestrial.*

The first describer of this species, D'UDEKEM, omitted a large number of details in both his description and his figures; some of these omissions, however, are probably due to the real absence

of the structures in question; thus he makes no mention of the salivary glands, which VEJDOVSKY said were inconspicuous; the rudimentary character of these glands distinguishes the species from *H. leptodera* and *H. dicksonii*. From D'UDEKEM'S account and figures the fourfold division of the oesophageal gland is not apparent; the whole structure, indeed, is described as a kind of muscular stomach; VEJDOVSKY, while naturally improving upon the account given by D'UDEKEM, did not recognize that the supposed stomach was really formed out of four diverticula of the oesophagus, a fact which was later demonstrated by MICHAELSEN (1). These four glands lie in the eighth segment. They are simple diverticula of the gut, with a lining of ciliated cells; the walls are a little folded, but there is in the figures of MICHAELSEN, at any rate, no trace of the intra-cellular lumina described by the same author in *Buchholzia*.

The dorsal vessel springs from the perioesophageal plexus in the ninth segment; it has three heart-like swellings in segments vii, viii, ix; the brain is longer than broad, and broader behind than in front; it is concave anteriorly, and is markedly notched behind; the funnel of the sperm-duct is rather small; the sperm-duct is long and coiled. The spermathecae consist of a pear-shaped distal part and of a duct of about the same length, which is somewhat dilated at its opening on to the exterior. D'UDEKEM has remarked that these organs present the appearance of glands attached to the alimentary canal, thus foreshadowing the discovery of MICHAELSEN that they open into it. The nephridia are said by D'UDEKEM to commence in the fourth segment.

(2) Henlea leptodera (VEJDOVSKY).

Archienchytraeus nasutus, EISEN, Öfv. Svensk. Akad., 1878, No. 3, p. 72.

Enchytraeus leptodera, VEJDOVSKY, Ench. 1879, p. 55.

E. (Archienchytraeus, EISEN) **leptodera,** MICHAELSEN, Ench. Möb., 1886, p. 46 et passim.

Archienchytraeus leptodera, ROSA, Boll. Mus. Zool. Torino, 1887, No. 29.

Henlea leptodera, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 32.

H. nasuta, MICHAELSEN, ibid., p. 32.

Definition. *Length,* 20 *mm.; number of segments,* 60; *setae straight,* 4 *to* 7. *Two oesophageal glands, with simple lumen. Hab.—Europe; Siberia. Terrestrial.*

MICHAELSEN considers that the present species is the same as EISEN'S *Archienchytraeus affinis;* this opinion is based upon an actual examination of both species by MICHAELSEN. EISEN did not mention the gut-diverticula, which are nevertheless, according to MICHAELSEN, present, and of exactly the same form as in *H. leptodera.* On the other hand, it may be pointed out that the brain appears from the figures to be a little different in form in the two 'species.' In *H. leptodera* the brain is more sharply notched behind than in the form called by EISEN *Archienchytraeus affinis* (cf. VEJDOVSKY, 3, Pl. x. fig. 1, and EISEN, 13, Pl. vi. fig. 2 *c*). As has already been mentioned, however, the brain is susceptible of alterations in form, according to the state of contraction of the muscles attached to it. EISEN has remarked that the species '*affinis*' is very

near to '*nasuta*'; upon this matter MICHAELSEN writes: 'EISEN'S Angabe von der Verwandtschaft des *A. affinis* mit seinem *A. nasutus* wäre zu bestätigen, falls die oben angeführte Synonymie angenommen werden müsste.'

UDE unites the two species on the following grounds: MICHAELSEN admitted that the two species stood very near to each other; but he distinguished them by the fact that in *H. nasuta* the appendices of the oesophagus were much more folded internally than in *H. leptodera*, and that in *H. nasuta* the setae, instead of being about the same length, are of different sizes. UDE found in the same individual of *H. leptodera* some bundles in which the setae were of the same length, and others in which the setae were unequal, like the typical *H. nasuta*; in one preparation it was found that the left oesophageal gland had a much less folded lumen than the right gland, thus doing away with the second difference between the supposed two species.

This species differs from the last in having well-developed salivary glands. The oesophageal glands are in the seventh segment, and open into the gut between this and the following segment. The brain is stated by UDE to be broader than long, but by VEJDOVSKY to be as long as broad—a difference, no doubt, to be accounted for on the supposition that the brain varies in its proportions according to the state of contraction of the muscles which are attached to it. There seems to be a little confusion as to the precise segment in which the dorsal vessel arises, and in which segments the dilatations are; VEJDOVSKY (**3**, p. 33) says that the dorsal vessel can be followed back as far as the seventh segment, and that the hearts are in segments vii, viii—two statements which do not appear to be reconcileable; in the systematic part of the same work (on p. 56) he places the heart-like swellings in segments vi, vii; the latter statement is followed by VAILLANT (**6**, p. 266). UDE, on the other hand, notes the commencement of the dorsal vessel in the same segment as in the last species, i. e. the ninth. The spermatheca is much as in the last species, but the duct is rather shorter than the pouch, and the latter is not dilated before its external pore.

(3) Henlea dicksonii (EISEN).

Archienchytraeus Dicksonii, EISEN, Öfv. Svensk. Akad., 1878, No. 3, p. 70.
Enchytraeus Dicksonii, VEJDOVSKY, Syst. u. Morph., 1884, p. 41.
Henlea Dicksonii, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 33.

Definition. *Length, 15 mm.; number of segments, 52; setae straight or a little bent to one side, of different sizes, 6–8 per bundle. No oesophageal glands. Hab.—Nova Zembla; Germany.*

EISEN'S account of this species is not sufficient to place it accurately; it was subsequently investigated by MICHAELSEN (**5**), who, however, had only a specimen *minus* the anterior end; hence he was unable to do more than state that the dorsal vessel, not being there visible, must originate in front of the clitellum. A complete description of all the important facts in the structure of this

species was afterwards given by UDE (1). UDE states that the description of the setae given by EISEN was not correct; EISEN figured (13, Pl. iv. fig. 7 *c*) the setae of the worm as like those of *Pachydrilus*. MICHAELSEN, in commenting upon this difference from other species of the genus, remarks that the arrangement is not like what is met with in the genus *Pachydrilus*. It is, however, more satisfactory not to have to explain away a distinct resemblance in this way.

The brain is double as long as broad (1·1–3 according to EISEN); it has a slight concavity posteriorly. The oesophageal glands are completely absent; in transverse sections the end of the oesophagus is seen to project into the interior of the intestine, thus forming a kind of valve. The dorsal vessel arises in segment viii; there are dilatations of this vessel in segments vi, vii, viii; the salivary glands are present, but their form is not described. The spermathecae are furnished with glands at their external pore; they are dilated into a pouch at the other end.

(4) Henlea puteana (VEJDOVSKY).

Enchytraeus puteanus, VEJDOVSKY, SB. Böhm. Ges., 1877, p. 301.
Henlea puteana, MICHAELSEN, Abh. Nat. Ver. Hamb., 1889, p. 34.

Definition. *Length*, 15 *mm.; number of segments*, 20; *setae of ventral bundles*, 8–10, *of dorsal*, 5–7. *Two pairs of spermathecae. Hab.—Bohemia.*

This species is at once to be distinguished by the presence of two pairs of spermathecae situated in segments iv, v. This is unique, not only in the genus, but in the family. The dorsal vessel arises in segment ix; this and the two segments in front have each a dilatation of the dorsal vessel. Nothing appears to be known as to the presence of oesophageal glands, or as to whether there is that marked distinction between oesophagus and intestine which characterizes other species of the genus. Nor are salivary glands mentioned. Considering the inequality of the setae in the dorsal and ventral bundles, it may perhaps be doubted whether the species is really a member of the genus *Henlea*; I leave it there in deference to the opinion of MICHAELSEN.

Genus ANACHAETA, VEJDOVSKY.

Syn. **Achaeta,** VEJDOVSKY.

DEFINITION. Setae absent; only represented by large gland-cells. Head pore at the tip of the prostomium; no dorsal pores. Dorsal vessel arises in front of the clitellum; blood colourless. An unpaired salivary gland opens behind the pharynx. Spermathecae not opening into the gut.

Our knowledge of this genus is almost entirely due to VEJDOVSKY; his account has been confirmed and extended in a few directions by MICHAELSEN (**5**) and UDE (**1**). The most salient character of the genus is the absence of setae. These appear to be represented by a series of large clear cells which occupy the precise position that the setae should, were they present; these cells are of large size—according to VEJDOVSKY's figure of *A. bohemica* (**24**, Pl. vii. fig. 1) one-third of the diameter of the body; they are pear-shaped in form, and have a single nucleus at the base. MICHAELSEN states that there are more than one nucleus to each of these cells, which, of course, heightens their resemblance to seta-sacs, these structures being usually formed of a group of cells. *A. eisenii* has two pairs of these bodies, while only one pair, the ventral, is to be found in the other species of the genus. The integument of *Anachaeta* is further remarkable for the existence of 'chlorophyll-glands.' There is in *A. eisenii* one of these to each segment, lying in the mid-dorsal line on a level with the seta-sacs; the chlorophyll-gland consists of a group of gland-cells, which open on to the exterior by a common duct. The chlorophyll in the interior of these cells was proved to be such by VEJDOVSKY. In *A. bohemica* there is a row of these glands, surrounding the middle of the segments, and it would appear from VEJDOVSKY's figure, illustrating these glands, that they are unicellular spherical bodies. VEJDOVSKY has stated that he never met with similar structures in other Enchytraeidae; it is possible, however, that *Fridericia striata* may have similar chlorophyll-glands (see above).

MICHAELSEN states that the longitudinal layer of muscles consists of a single layer of hollow fibres, without the additional layer that exists in so many species, such as *F. ratzelii.* The clitellum (in *A. bohemica*, at any rate) occupies only the lateral and ventral regions of the body-wall (cf. *Aeolosoma*). The dorsal vessel arises from the intestinal sinus in front of the clitellum; it has three dilated heart-like swellings, the position of which varies according to the species. The salivary gland is unpaired, and opens behind the pharynx; there is a little confusion about the unpaired character of these glands; VEJDOVSKY says in the description of the species *A. eisenii* (**3**, p. 60): 'Die Speicheldrüsen stellen kurze,' &c., and again, in the definition of the genus (p. 50): 'Die Segmentalorgane modificiren sich im 3–5. Segmente zur Speicheldrüse.' On a previous page also the same facts are substantially stated. In a later work, however (**24**, p. 106), VEJDOVSKY remarks upon the unpaired condition of these glands in the genus *Anachaeta* ('bei *Anachaeta* dagegen unpaarig'), though the observations recorded in that work concern, so far as this genus is treated of, the species *A. bohemica.* UDE (**1**, p. 98) says that the salivary gland is unpaired in *A. eisenii.*

The spermathecae in this genus do not communicate with the lumen of the gut,

as is so very generally the case with the Enchytraeidae. Both species have taste-papillae, and in both the brain is convex posteriorly.

(1) Anachaeta eisenii, Vejdovsky.

Achaeta Eisenii, Vejdovsky, SB. Böhm. Ges., 1877, p. 300.

Anachaeta Eisenii, Vejdovsky, Ench., 1879, p. 60.

Definition. *Length, 12 mm.; number of segments, 30; four seta-glands in each segment. Spermathecae oval, with a duct not sharply marked off from pouch. Hab.—Bohemia; Germany.*

The structure of this species is described and illustrated in Vejdovsky's Monograph of the Enchytraeidae. A good many of the characters of the species have been already dealt with in the account of the genus. A few remain, which are either of less importance or differ in the two species, to be noted here. The dorsal vessel arises, according to Vejdovsky (**3**, pp. 33 and 61), in the sixth segment, and has two dilated hearts, one in this segment and one in the preceding segment; Ude, however, who has more recently examined the worm, says that this vessel arises in segment viii, and that there are three swellings, which, therefore, presumably lie in segments vi, vii, viii. The nephridia have a long anteseptal region, which is constricted off from the postseptal half of the organ by the septum; the lumen is very undulating in its course in the anteseptal part of the nephridium. In a longitudinal section through the body-wall (**3**, Pl. i. fig. 2 *gl*) Vejdovsky represents a series of epidermic glands of large size which lie at the junction of every two segments, occupying the position, in fact, that is occupied in the genus *Fridericia* by the dorsal pores, elsewhere wanting. Vejdovsky says nothing of these glands in his Monograph (**24**); it is, therefore, to be supposed that there is no special peculiarity in the arrangement, but that they are simply some of the numerous glands which occur in the integument generally. The funnel of the sperm-duct is five or six times as long as broad; the duct is spirally twisted, forming a very compact coil; the external pore is beset with prostates. The spermatheca is an oval pouch, passing gradually into the duct; the external pore is beset with glands.

(2) Anachaeta bohemica, Vejdovsky.

Anachaeta bohemica, Vejdovsky, Zool. Anz., 1879, p. 183.

Definition. *Only two rows of seta-glands, corresponding to the dorsal series of setae. Spermatheca consisting of a small oval pouch, into which opens laterally a very long diverticulum, expanded into an oval pouch at extremity. Hab.—Bohemia.*

This species has been studied by VEJDOVSKY (**24**) and, later, by MICHAELSEN (**5**). The shape of the spermatheca is not referred to, unless there is an error in the lettering of the Plate (**24**, Pl. vii. fig. 22); I am inclined to think that this must be the case. For both VEJDOVSKY and UDE agree in their descriptions of the spermathecae of *A. eisenii*, which differs from the figure given of the spermathecae of that species in the great work of VEJDOVSKY. In that figure the spermatheca is represented as consisting of a short oval pouch opening on the exterior; into the side of this, and at right angles to it, opens a long and narrow duct which is only a little dilated just where it opens into the pouch; at the end of this long duct is an oval swelling which lodges the sperm; it seems to me that the long duct, widening out at its blind extremity may, perhaps, be compared to the diverticulum of the spermathecae of other Enchytraeidae. If this figure really refers to *A. eisenii*, then the differences between the two species will be the absence of the ventral pair of seta-glands, and the presence of three pairs of hearts in *A. bohemica* in segments iv–vi. From the last heart, and from the dorsal vessel in front of it, arise three pairs of perivisceral; the anteseptal part of the nephridium is shorter than in the last species, and the external orifice is beset with glands similar to those found round the aperture of the spermathecae of both species; the nephridia are furnished with a distinct terminal vesicle, which appears to be wanting in the other species of the genus.

Genus BRYODRILUS, UDE.

DEFINITION. Setae ʃ-shaped. Head-pore between prostomium and buccal segment. Four oesophageal glands in VII. Blood colourless. Dorsal vessel arises in XII, without cardiac body.

This genus is, of course, easily to be distinguished on account of the four oesophageal glands, which are arranged dorsally, ventrally, and laterally; the dorsal vessel, by an exception unique in the family, does not arise from these pouches, but behind them. There is only one species—

Bryodrilus ehlersi, UDE.

B. Ehlersi, UDE, Zool. Anz., 1892, p. 344.

Definition. *Length, 12 mm.; setae 4–5 per bundle. Three pairs of septal glands. Brain two to three times longer than broad, concave anteriorly. Spermathecae, without diverticula, communicating with gut. Hab.—Germany. Terrestrial.*

At present we only know this species from a preliminary description of UDE. The funnel of the sperm-duct is described as two to three times as long as broad. The perivisceral corpuscles are large and disc-shaped. The nephridia have a small anteseptal part; the duct arises from the postseptal part, just behind the septum.

Genus PARENCHYTRAEUS, HESSE.

DEFINITION. Setae straight. Head-pore between prostomium and buccal segment. Blood colourless; dorsal vessel arises in XII; ventral vessel undivided after first segment. No oesophageal glands. Copulatory gland present.

The genus is to be distinguished by the limited extent of the divided part of the ventral vessel. Only one pair (of the three pairs) of perioesophageal trunks join the divided ventral vessel.

Parenchytraeus litteratus, HESSE.

P. litteratus, HESSE, Z. wiss. Zool., 1893, p. 2.

Definition. *Length,* 11 *mm.; number of segments,* 45*; prostomium and buccal segment with papillae. Three pairs of septal glands (in IV–VI). Brain* $1\frac{1}{2}$ *times as long as broad, concave in front. Spermatheca, without diverticula, communicating with gut by wide orifice. Hab.—Naples, seashore.*

The specific name is taken from the sculpturing (like Arabic letters) of the cuticle. The copulatory glands are in iv, v, xiii, xiv.

Group MEGADRILI.

SUPERFAMILY MEGASCOLICIDAE.

I agree with ROSA in the necessity for uniting together the families Perichaetidae, Acanthodrilidae, and Cryptodrilidae; but I do not go so far with him as to include also the Eudrilidae. I consider that this family differs as much from either of the three enumerated as do any two families of earthworms. The three which I here unite to form the Megascolicidae are very difficult to separate from each other; the line which separates *Dichogaster* from the Acanthodrilidae is a very slight one; *Microdrilus*, too, is not far removed from *Benhamia*. The detailed resemblances between these

various types will be found treated of in the introduction to the description of the genera and species of the subfamily Cryptodrilidae. On the other hand, the Perichaetidae are obviously nearly connected, through the remarkable forms with eight setae in anterior segments, with *Cryptodrilus* and its immediate allies.

Certain peculiarities of structure are found only in the family Megascolicidae, and some of these occur in all of the three subfamilies into which it is divided. The principal of these is the peculiar form of the spermiducal gland, which I term 'lobate'; this kind of spermiducal gland is found in all the Perichaetidae with a very few exceptions, and in a great many of the Cryptodrilidae; at first sight it may appear not to exist in any Acanthodrilid; but the genus *Diplocardia* has spermiducal glands, which are, at any rate, a step in this direction. In no other family of the Oligochaeta do glands of this particular description exist. In this family only are there nephridia which ramify within the coelom and open on to the exterior by numerous pores; the integumental network of certain Eudrilids, which is derived from a series of paired nephridia being a different thing.

Among the higher Oligochaeta the Megascolicidae are the only genera which have spermathecae furnished with diverticula of a different structure to the pouch; and, furthermore, there are only a few exceptions to the universality of these spermathecal appendages in the group.

The very general position of the male pore upon the eighteenth segment of the body is a characteristic of the Megascolicidae; in no genus are the male pores far from this segment, if they are not upon it.

These are the principal facts which lead me to associate together the three families Perichaetidae, Cryptodrilidae, and Acanthodrilidae, within what I may term a super-family, Megascolicidae.

It is noteworthy too that certain peculiarities of structure which occur in the group are confined to it, and are found in more than one of its three families.

The continuous circle of setae, so universal in the Perichaetidae, occurs nowhere else among the Oligochaeta except in the Acanthodrilidae. Even in so rare a point of structure as the enclosure of the dorsal blood-vessel in a coelomic space we find that the only two examples, *Deinodrilus benhami* and *Megascolides australis*, are in this group. The peculiar intestinal glands of *Megascolex coeruleus* are repeated in *Typhaeus*. The peculiar condition of the gizzard in *Perichaeta*, occupying, as it does, two segments, with a suppression of the intervening mesentery, is repeated in the genus *Typhaeus*.

As to negative characters, these are numerous. The most striking, perhaps, though by it the family does not contrast with the Eudrilidae, is the absence of specially

modified clitellar setae; to this rule there is but one exception, viz. *Perichaeta houlleti;* and in this worm the modified genital setae are not at all like those of the Lumbricidae or the Geoscolicidae.

The mutual relationships of the three subfamilies are more fully discussed in the following pages.

Family PERICHAETIDAE.

Definition. **Earthworms with numerous setae per segment arranged in a continuous circle, or with dorsal and ventral gaps; male pore nearly always on XVIII. Gizzard always present; calciferous glands absent or present; intestine frequently with two (occasionally more) caeca, and a rudimentary typhlosole. Nephridia diffused or paired. Spermiducal glands generally lobate; penial setae present or absent; spermathecae with one or two diverticula[1].**

This family of earthworms is one of the largest; it comprises over 100 species, which will be in this work relegated to four genera. This family, like many others, contains some of the largest as well as some of the smallest earthworms. There are no species known which are of greater size than *Perichaeta musica,* while other species do not reach to a greater length than two inches.

Anatomical Characters[2].

The continuous circle of *setae* does not absolutely distinguish the family as it was formerly thought to do. I am quite of Benham's opinion that his genus *Plagiochaeta* is an Acanthodrilid. The setae are in the species of the genus *Megascolex* interrupted dorsally and also ventrally by a gap where setae are absent. In the remarkable species which I formerly placed in the genus *Anisochaeta* there is an interesting transition to the worms with eight setae to the segment; that is what is found in the anterior segments of those species, while posteriorly the numerous setae of the typical species exist. As a general rule the setae are less numerous in the most anterior segments—the reason for which may be no more recondite than that these segments are of less circumference; the number of setae to the segment varies and often affords a valuable series of characters for the systematist; the largest number of setae in a single segment is shown in *Pleionogaster horsti,* where there may be as many as 151.

[1] Very exceptionally absent—*P. ijima.*

[2] For the affinities of the Perichaetidae see under Cryptodrilidae and Acanthodrilidae.

The setae are as a rule similar on all the segments of the body; there are, however, exceptions to this rule. In many species, for example, the setae upon some of the anterior segments are stouter than those which occur elsewhere; in *P. sinensis* this is the case with the setae of the segments vi, vii, viii, ix. In other species the ventral setae are larger than the rest; in *P. houlleti* there are three or four setae on each side of the nerve-cord, which are distinctly longer as well as thicker than those upon the remaining part of the segment; in this case there is a gradual increase in size, commencing a little way from the median ventral line and culminating at the last seta on each side. In the genus *Perichaeta* there are either very few or no setae upon the clitellum when this is mature. *P. taprobanae* is one of the few species of the genus which has setae forming continuous circles upon the clitellar segments; it is common, if not universal, among the species of *Megascolex* to have setae upon the clitellum. When setae are present upon the clitellum they are never, except in *P. houlleti*, in any way different from those of other segments. In the above-mentioned species the clitellar setae are shorter than those upon other segments, and have a truncated form and a bifid extremity. The *clitellum* is in the majority of species (in *all* belonging to the genus *Perichaeta* itself) complete, i. e. it completely encircles the body; in this genus too, with very few exceptions, there are only three segments in the clitellum—only two apparently in *P. upoluensis*. *Megascolex* has the most extensive clitellum (nine segments in one species), and here the clitellum is only complete anteriorly; it is deficient ventrally behind.

The male pore is nearly invariably upon the eighteenth segment; the only exceptions are *M. attenuata*, where it is upon the seventeenth, and *M. enormis*, where it is between the seventeenth and eighteenth.

The *prostomium* in the Perichaetidae is rarely continued by grooves as far as the end of the buccal segment; it does, however, as a rule, extend for a certain distance on to the buccal segment.

Genital papillae are very general in this family; they are found in nearly all the species. When present they may occur in the neighbourhood of the spermathecae as well as near to the male pores. With the papillae are always connected glands of a peculiar kind whose structure has been described above (p. 144); the papillae in fact are but the external pores of these glands.

The *alimentary canal* of the Perichaetidae is chiefly remarkable for the two caeca of the intestine, which arise in the twenty-sixth segment, and are directed forwards; these were first discovered by VAILLANT (**3**), and have since been found to be, with a few exceptions, characteristic of the genus *Perichaeta* itself, and they serve as a means of distinguishing that genus from *Megascolex*. It is a remarkable fact that similar

caeca occur in the not nearly allied genus *Urobenus* (a Geoscolicid); with this exception they are limited to the present family; in a few species, all natives of Japan, the two caeca are replaced by six or seven, as was first pointed out by HORST (**9**); but in these cases there is always one pair which are very much larger than the others. A gizzard is, so far as we at present know, invariably found in this family; its position varies. In the genus *Megascolex* and in *Diporochaeta* it is placed far forwards—in the fifth, sixth, or in the seventh and eighth segments; in the genus *Perichaeta* the gizzard appears with rare exceptions to occupy two segments—the eighth and the ninth. It is often stated to occupy three segments; and from one point of view it often does; for the septum which bounds the ninth and tenth segments is pushed so far backwards by the growth of the gizzard that the setae belonging to this (the tenth) segment lie to the forward side of the septum that intervenes between the ninth and tenth segments. In this genus (*Perichaeta*) it is nearly always the case that the septum dividing segments viii/ix is absent.

It is a doubtful point whether true calciferous glands occur in the majority of Perichaetidae; in the genus *Perichaeta* they certainly do not; they are represented simply by an increased vascularity of the oesophagus in certain segments; in *Diporochaeta*, however, there are two pairs of calciferous glands in x, xi; these are, however, not such distinct caeca of the gut as the same structures are in *Pontoscolex;* they present the appearance of local thickenings of the walls of the oesophagus [1]; the same state of affairs appears to characterise the genus *Megascolex* according to FLETCHER. In *Diporochaeta* crystals occur in the calciferous glands similar to those which are found in the calciferous glands of other earthworms. Unique in the family is *M. coeruleus* for the series of intestinal glands, which, however, are again met with in *Typhaeus*. These are placed upon the dorsal surface of the intestine in segments xxi–xxxix (about). Their lumen is lined by a much-folded cellular membrane; their structure in fact is not unlike that of the calciferous glands.

A typhlosole has been stated to be wanting in the Perichaetidae; it is as a rule present, but never appears to attain to such dimensions as it does, for example, in the Acanthodrilidae.

With regard to the *vascular system*, a subnervian vessel, sometimes stated to be absent, is present at any rate in some forms. The details of the circulatory system, at present only known in *M. coeruleus*, will be gone into below. The last pair of hearts is usually in segment xii or xiii.

[1] Besides, this genus is possibly not referable to this family, but rather to the Acanthodrilidao (see below).

Genera of Perichaetidae.

KINBERG (pp. 101–103) distinguished no less than six genera of those species characterised by possessing more than eight setae to each segment; it is possible, however, that some of them might be Acanthodrilidae as defined in the present work.

These 'genera' are thus defined by KINBERG:—

AMYNTAS, n. Lobus cephalicus, e parte superiore anteriore segmenti buccalis formatus, marginibus lateralibus solis distinctis, segmento illo multo angustior et brevior; segmenta anteriora posterioribus duplo longiora; setae radiatim et seriatim collocatae, minutae, laeves, 50–60: nae posteriores magis numerosae.

NITOCRIS, n. Lobus cephalicus transversus, latus, obtusus, superus, postice arcuatus, integer; segmenta anteriora et posteriora reliquis longiora, medio carinata; setae series transversas formantes, parvae, 18–52: nae posteriores magis numerosae; cingulum nullum.

PHERETIMA, n. Lobus cephalicus terminalis, transversus, ad marginem anteriorem superiorem segmenti buccalis affixus; setae radiatim et seriatim positae, segmentorum posteriorum illis anteriorum magis numerosae; foramina dorsalia; cingulum; tubercula ventralia duo.

RHODOPIS, n. Lobus cephalicus haud distinctus, e margine anteriore superiore segmenti buccalis formatus; orificium oris terminale plicis papillaeformibus instructum; setae radiatim et seriatim positae, minutae, segmentorum posteriorum illis anteriorum magis numerosae. Tubercula ventralia duo in sutura segmentorum obvia.

PERICHAETA (SCHMARDA), ex parte. Setae numerosae, anteriores et posteriores numero aequales.

LAMPITO, n. Lobus cephalicus transversus, ovalis, integer; segmentum buccale antice non incisum; tubercula ventralia duo pone cingulum sita; setae radiatim et seriatim positae, anteriores posterioribus numerosiores, laeves, fusiformes, apice parum curvato.

Several of the species referred to these six genera have been subsequently examined by PERRIER and by myself; they proved to be 'merely variations on the theme of *Perichaeta*.' It is hardly necessary at the present time to insist upon the worthlessness of the above characters as serving to discriminate genera. And yet VAILLANT (**6**, p. 63) admits them as subgenera, including PERRIER'S genus *Perionyx* and a new subgenus

— *Perriera* (for *P. biserialis*). These subgenera are indicated in a table which is slightly altered from that of KINBERG.

In 1871 PERRIER added a new genus *Perionyx* to *Perichaeta*, considering it possible, however, that this genus might later be regarded as not really distinct. The principal character in which it differs from *Perichaeta* is in the presence of paired nephridia ('la netteté de ses organes segmentaires'), the inclusion of the male pores in a circumscribed ventral area, the position of the spermathecae, and the extent of the clitellum.

The two first characters alone distinguish the genus as now defined. When PERRIER wrote of the *position* of the spermathecae as serving to distinguish the genus he must have meant the *structure* of these pouches, i. e. the absence of a diverticulum. There is nothing remarkable in their position. This genus has been accepted by all subsequent writers except VAILLANT, and is admitted here. In 1881 I added a new genus *Pleurochaeta*; the identity of this form with TEMPLETON'S *Megascolex*, suspected by VEJDOVSKY (**24**), was later proved by myself (**5**).

Below I have something to say with reference to the confusion which has been made with the genera *Megascolex* and *Perichaeta*; here I am concerned with the genera of Perichaetidae alone. The distinction between *Perichaeta* and *Megascolex* was first pointed out by SCHMARDA, who introduced the latter name; his distinctions, however, were based upon a misunderstanding of TEMPLETON'S description of *Megascolex*; indeed he re-described *M. coeruleus* as *P. leucocycla*. BAIRD (**1**) denied that there was any distinction between any two such genera; but his opinion is rendered of little value by the fact that he paid no attention to internal characters, and for the matter of that but little to external characters also.

In 1883 I pointed out that two genera, *Megascolex* and *Perichaeta*, might be distinguished as follows:—

PERICHAETA.

(1) Ring of setae upon each segment discontinuous at one or more points.
(2) Clitellum occupying more or fewer segments of the body than three.

MEGASCOLEX.

(1) Ring of setae continuous.
(2) Clitellum occupying segments xiv–xvi.

It will be observed that I have here defined as *Perichaeta* the worms now referred to *Megascolex* and *vice versa*. This was on the strength of BAIRD'S statement that *Megascolex* and *Perichaeta* were the same. I should, however, in that case have allowed the name *Perichaeta* to be dropped, and have introduced a new name.

A year after the publication of the paper just referred to I re-defined the genera *Perichaeta* and *Megascolex* in consequence of the discovery that my *Pleurochaeta* was identical with *M. coeruleus*. The definitions were as follows:—

PERICHAETA, SCHMARDA.

Syn. Megascolex, Auct.

DEFINITION. Setae generally arranged in a continuous row round the middle of each segment; clitellum occupying two, three, or four segments (XIV–XVII). Male generative apertures paired, and situated upon eighteenth segment of body, which is always behind the clitellum; genital papillae occasionally developed in neighbouring segments. Female generative aperture single, and within the clitellum, upon the fourteenth segment. Two pairs of testes, more or less solid and compact, in segments XI and XII; terminal portion of vas deferens on either side connected with the duct of a large prostate gland. Copulatory pouches varying in number from two to four pairs, and provided each with a variously shaped supplementary pouch or pouches. Intestine with a caecum on either side in twenty-sixth segment.

During the last few years a large number of species of '*Perichaeta*' have been described by FLETCHER and SPENCER in Australia. The principal characters of these are shown in the table on pp. 366, 367.

This table shows that the majority of the species dealt with are referable to the genus *Megascolex* as defined in this work; three species, viz. *P. queenslandica*, *P. darnleiensis*, *P. peregrina*, are as clearly referable to the genus *P. sensu stricto*; 'they are all typical species of the genus *Perichaeta*,' says FLETCHER.

Several species, e.g. *P. attenuata*, *P. enormis*, *P. coxii*, are remarkable on account of the diminished number of setae on the anterior segments of the body; the anterior half of the body would be, as FLETCHER has pointed out, indistinguishable from a Cryptodrilid if the posterior half were missing. I have thought that this important character, which serves to link the Perichaetidae with the Cryptodrilidae (56) should be regarded as being of generic value. I now think that this genus cannot be retained, for the reason that worms with tubular spermiducal glands and paired nephridia, as well as those with diffuse nephridia and lobate spermiducal glands, have sometimes a reduction in the setae of the anterior segments.

The species *P. bakeri*, *P. barronensis*, *P. canaliculata*, *P. terrae reginae*, and some others, have paired nephridia and tubular spermiducal glands. In having paired nephridia and tubular glands *P. intermedia* (=*P. novae-zelandiae*) differs

from most other worms which have been called '*Perichaeta*,' except those that have just been referred to. It might be supposed that the differently arranged nephridia were present in addition to the paired tubes, as in *Megascolex armatus*. In *P. intermedia* this diffuse network is certainly not present, nor in *P. dendyi*, &c.; the excretory system is represented by the paired tubes and nothing else. The tubular atria occur in *P. bakeri*, of which FLETCHER says (**4**, p. 618): 'The two prostates occupy xviii and xix, each of them being a long narrow body coiled into a compact mass, the duct coming off from the anterior portion of the gland[1].' It does not appear clear whether *P. barronensis* has the same kind of 'prostate'; this is what FLETCHER (**2**, p. 961) writes on the matter: 'In xiii a pair of prostates, their proximal portions long, narrow, continuous with the genital ducts, looking more like convoluted thick-walled tubes than solid glands, their distal portions a little more compact;' at any rate, *P. dendyi* and several of SPENCER'S species have. I have proposed to separate *P. intermedia* as a distinct genus of Perichaetidae, characterised by the two points mentioned above. On studying the worm afresh for the purposes of the present work, and in the light of BENHAM'S paper upon the curious Acanthodrilid genus *Plagiochaeta*, I am not convinced that *P. intermedia* might not perhaps be referred to the Acanthodrilidae; the smooth appearance of the worm is much more suggestive of an Acanthodrilid than a Perichaetid, and such trifles often are indications of affinity. Unfortunately, I am unable to report upon the relation of the sperm-duct to the distal glands, a point of great importance in the discrimination of such affinities as those treated of here. I should include in this genus a number of the Australian species duly enumerated below.

MICHAELSEN has proposed to separate under the name of *Pleionogaster* 'those Perichaetidae, which have several gizzards behind the clitellum in addition to the one in front.' The two species which refer to this genus, viz. *P. jagori* and *P. samariensis*, agree with my *P. horsti*, described some years previously (**41**), in the following characters besides that mentioned by MICHAELSEN:—

The setae are very numerous in some of the segments; there are as many as 150 on the sixth segment of *Pleionogaster horsti*. As in the genus *Megascolex* there are no caeca, and the clitellum is composed of four segments; the anterior gizzard too is peculiar in occupying a single segment only, the eighth. The setae as in *Perichaeta*, have no dorsal and ventral gaps; the characters of these species are, in fact, intermediate between those of *Megascolex* and *Perichaeta*, with the addition of a few characters peculiar to the species, and not found either in *Perichaeta* or in *Megascolex*.

[1] But the description of an 'U-shaped' duct is not, perhaps, in accord with the suggestion that *P. bakeri* has tubular atria.

TABLE OF THE SPECIES OF AUSTRALIAN *PERICHAETA*.

	LENGTH.	SEGMENTS.	CLITELLUM.	SETAE.	DORSAL PORES.	GIZZARD.	INTESTINE BEGINS.	LAST PAIR HEARTS.	SPERMATHECAE.	SPERMIDUCAL GLANDS.	OTHER STRUCTURES.—REMARKS.
P. exigua	60 mm.	115	xiv–$\underline{\text{xvii}}$ [1]	20–30 per segmt; slight gaps.	v/vi	v	xvi	xii	viii	Lobate, with U-shaped duct.	
P. monticola	155 mm.	151	$\overline{\text{xiii}}$–$\underline{\text{xvii}}$	16–50; gaps.					viii, ix		Structures not mentioned 'as in *P. australis*.
P. canaliculata	145 mm.	160	$\overline{\text{xiii}}$–$\underline{\text{xix}}$	16–50; gaps.	v vi	vi	xvii no caeca.	xii	vii, viii, ix	Lobate, with U-shaped duct.	Nephridia paired [?]
P. stirlingi	220 mm.	200	$\overline{\text{xiii}}$–xvii	30–40; gaps.	iv/v	v	xviii no caeca.	xiii	vii, viii, ix	Lobate, with straight duct.	
P. raymondiana	260 mm.	135	xiii–xvii	28–36; gaps.		v			vii, viii, ix		Oviducal pores paired; structures not mentioned 'as in *P. austrina*.'
P. hamiltoni	143 mm.	148		16–30; gaps.							'In other respects . . . like *P. austrina*.'
P. wilsoniana	94 mm.	120	xiv–$\underline{\text{xx}}$	20–28; gaps.							'In other respects . . . like *P. austrina*.'
P. fecunda	74 mm.	115	$\overline{\text{xiii}}$–$\underline{\text{xvii}}$	20–30; gaps.	iv/v	v	xvi no caeca.	xiii	(vi, vii), viii, ix		Oviducal pores paired.
P. macquariensis	180 mm.	200	xiv–xvii	18–44; gaps.	iv/v			xiii	vii, viii, ix		Oviducal pores paired. Penial setae.
P. terrae reginae	190 mm.	144	? xiii–xxi	40–60; gaps.	vi/vi				v, vi, vii, viii		Oviducal pores paired; nephridia pores paired.
P. macleayi	120 mm.	140	$\overline{\text{xiii}}$–xvii	16–40	v/vi						'In other respects like *P. australis*.'
P. tenax	157 mm.	150	$\overline{\text{xiii}}$–xvii	36–60; gaps.	iv/v	v	xvi no caeca.	xii	viii, ix	Ducts very short.	Oviducal pores paired; dorsal vessel partly double.
P. dorsalis	192 mm.	135	xiv–$\underline{\text{xvii}}$	16–30; gaps.	iv/v	v (or vi)	xvii	xiii	vi–ix	Ducts ʃ-shaped.	Oviducal pores paired.
P. bakeri	92 mm.	140	$\overline{\text{xiii}}$–$\underline{\text{xvii}}$	22–36; gaps.	iv/v	v	xvii	xii	v–ix	Tubular [?], duct U-shaped.	Oviducal pores paired; nephridia paired; penial setae.
P. austrina	90 mm.	128	xiv–$\underline{\text{xvii}}$	16–40; gaps.					vii–ix	Lobate, duct short.	Other organs as in *P. australis*.
P. australis	144 mm.	140	xiv–xvi	20–36; gaps.	v/vi	vi	xvi no caeca.	xii	viii, ix	Lobate, duct U-shaped.	Oviducal pores paired.
P. gracilis	110 mm.	155	xiii–xvi	20–24; gaps.	v/vi	vi	xvii no caeca.	xii	vii–ix	Lobate, duct U-shaped.	Oviducal pore single.
P. barronensis	62 mm.	125	xiv–xvii	40; gaps.	iv/v	vii [?]	xvi no caeca.	xiii	v–vii	Tubular [?]	Nephridia paired.
P. queenslandica	150 mm.	120	xiv–xvi	60; no gaps.	xii/xiii	vii, viii	xv with caeca.	xii	v–viii	Lobate, duct straight.	Oviducal pores paired [?]

[1] The lines above and below the numbers of the segments occupied by the clitellum indicate that the particular segment is only partly invaded by clitellar tissue.

TABLE OF THE SPECIES OF *PERICHAETA* (*continued*).

	LENGTH.	SEGMENTS.	CLITELLUM.	SETAE.	DORSAL PORES.	GIZZARD.	INTESTINE BEGINS.	LAST PAIR HEARTS.	SPERMATHECAE.	SPERMIDUCAL GLANDS.	OTHER STRUCTURES.—REMARKS.
P. darnleiensis .	155 mm.	108	xiv–xvi	60–66; no gaps.	xi/xii	ix/x	xvi with cacae.	xiii	vi–ix	Duct curved, with terminal sac.	Oviducts 'appear' to open separately.
P. peregrina . .	130 mm.	108	xiv–xvi	40–46; no gaps.	xi/xii	viii/ix	xvi with caeca.	xiii	vi–ix	Duct U-shaped.	Oviducal pores said to be paired.
P. indissimilis .	61 mm.	110	xiv–xvi	20–30.	iv/v	v			vi–ix		
P. attenuata . .	100 mm.	220	xiii–xvii	8–28.	xii/xiii			xii	viii, ix		
P. enormis. .	87 mm.	220		8–16.					with two diverticula.		In other respects agreeing with *P. attenuata*
P. coxii . .	190 mm.		xiii–xvii	8–20.	xiii/xiv	v	xvi no caeca.	xiii	viii, ix	Lobate, ducts long and coiled.	Oviducal pores paired.
P. copelandi . .	125 mm.	175	xiii–xvii	20–50; gaps.	iv/v	v	xvii	xii	v–ix	Tubular.	Nephridia paired.
P. obscura. . .	70 mm.	100	xiii–xvi	18–24; gaps.	iv/v	v	xvii	xii	v–ix	"	" "
P. sylvatica . .	75 mm.	100	xiii–xvii	20–24.	v/vi	v	xv	xii	v–ix	Lobed.	
P. hoggii . .	120 mm.	125	xiii–xvii	24.	iv/v	v	xv	xii	v–ix	"	
P. hallii . .	40 mm.	100	xiii–xvii	24–32.	iv/v	v	xvii	xii	v–ix	"	
P. rubra . . .	55 mm.	90	xiv–xvi	20–24.	iv/v	v	xv	xii	v–ix	"	
P. frenchii. . .	100 mm.	110	xiii–xvii	20–24.	iv/v	v	xv	xii	v–ix	"	
P. steelii . . .	60 mm.	120	?	22–24.	iii/iv	v	xv	xii	v–ix	"	
P. lateralis . .	90 mm.	126	xiv–xvi	20–24.	iv/v	v	xvii	xii	vii–ix	"	
P. dendyi . . .	60 mm.	160	xiv–xvi	22–30; in pairs.	iv/v	v	xviii	xii	vi–ix	"	Nephridia paired; prostomium complete.
P. lochensis . .	75 mm.		xiii–xvi	18–39.	present.	v	xvii	xii	v–ix	Tubular.	Nephridia paired.
P. dubia . . .	45 mm.	100	xiii–xvii	12–24.	iv/v	v	xviii	xii	v–ix	"	Nephridia paired; prostomium complete.
P. walhallae . .	25 mm.	88	xiv–xvi	20–24.		v	xv (?)	xii	v–ix	"	Nephridia paired.
P. dicksonia . .	50 mm.		xiv–xvi	20–22.	iv/v	v	xvii	xii	v–ix	"	Nephridia paired; prostomium complete.
P. alsophila	50 mm.	104	xiv–xvi	20–26.	iv/v	v	xvii	xii	vi–ix	"	Nephridia paired.
P. fielderi . . .	150 mm.		xiii–xviii	12.	present.	v	xvii	xiii	viii, ix	Lobed.	Peptonephridia present.
P. frosti . . .	150 mm.	220	xiv–xvii	?	iii/iv	vi	xv	xiii	v–ix	"	Dorsal vessel partly double.
P. goonmurk . .	110 mm.	150	xiii–xix	8–16.	?	v	xvi	xi	v–ix	"	Dorsal vessel double.
P. yarraensis. .	140 mm.		xiii–xvii	8–28.	v/vi	v	xvii	xii	v–ix	Tubular.	Paired nephridia; prostomium complete.
P. tanjilensis. .	90 mm.		xiv–xvii	8–20.	iv/v						Other organs as in last.

Considering the sum-total of these characters, I am quite inclined to agree with MICHAELSEN, and to separate the species as a genus for which the name *Pleionogaster* may be used.

A form which doubtless merits generic separation is BOURNE'S *P. stuarti.* It seems to come near to *Megascolex fecundus* in having two pairs of spermiducal glands, in common with which the sperm-ducts open. Another peculiarity is the presence of modified setae in the neighbourhood of the spermathecae. I have already proposed the generic name of *Hoplochaeta* for this worm, but, pending further investigations by the discoverer of the species, it had better perhaps be withdrawn.

Five species, *P. stelleri*, *P. everetti*, *P. papillata*, *P. sarawacensis*, and *P. kinabaluensis*, differ in the very remarkable character of possessing a large number of spermathecae in each of the two segments where these structures occur. The spermathecae are not, as for example in *Microchaeta*, of very small size. They are, however, rather smaller than the paired spermathecae of *Perichaetae* of a similar size. In addition to this point of difference, none of the species enumerated possess intestinal caeca. They are all of considerable size, and are restricted to the islands of the Indian archipelago, being especially characteristic of Borneo. It is possible that they ought to be separated into a distinct genus, but I prefer to leave them in the genus *Perichaeta*.

Another doubtful form is my *P. ceylonica.* Its dubious position is largely owing to the incomplete account which I was able to give of it. The arrangement of the setae seems to indicate that the worm should be referred to the genus *Perichaeta.* On the other hand, the absence of setae between the male pores, and the extension of the clitellum on to the eighteenth segment, as well as the presence of penial setae, are characters hitherto only met with in the genus *Megascolex.* Even discounting the clitellum, which in one true *Perichaeta* is of equal extent, there is a closer resemblance to *Megascolex* than to *Perichaeta.* The species is quite unique among the Perichaetidae in possessing two pairs of glandular appendages to the sperm-ducts, both situated in the same segment. Which of these is connected with the sperm-ducts I am not able to say. For the present, pending further information about the species, I refer it to the genus *Megascolex.* Another species, however, '*Perichaeta*' *fecunda* of FLETCHER, has two pairs of spermiducal glands; these do not, however, as in *M. ceylonicus*, open on to the same segment, but on to the consecutive segments xviii and xix. A bilobed spermiducal gland, which is the earliest or latest stage in the same series, occurs in *Megascolex.*

The distinctness of this genus is somewhat marred by SPENCER'S *P. dendyi;* there are several 'Perichaetes,' which agree with the New Zealand form in having tubular

spermiducal glands and paired nephridia; but the above-mentioned species has 'flattened' glands. *P. yarraensis* again, and one or two allied forms, combine the characters of my two genera, *Diporochaeta* and *Anisochaeta;* for they have a reduced number of setae on the anterior segments together with coiled spermiducal glands and paired nephridia. It is, in fact, as hard, if not harder, to introduce order into the arrangement of the Australian Perichaetidae as to classify in a reasonable way the Australian Cryptodrilidae. It is possible that a microscopic examination of the spermiducal glands may show that some glands apparently of the tubular type characteristic of the Acanthodrilidae are not really so. In the meantime it seems to me to be legitimate to retain *Diporochaeta*.

The following species are *incertae sedis*:—

(1) *Pheretima montana*, KINB., Otahiti.
(2) „ *californica*, KINB., California.
(3) *Lampito mauritii*, KINB., Mauritius.
(4) *Megascolex lineatus*, HUTTON, New Zealand.
(5) *Perichaeta coerulea*, PERRIER, Philippines.
(6) „ *luzonica*, PERRIER, Philippines.
(7) *Megascolex sylvestris*, HUTTON, New Zealand.
(8) *Perichaeta corticis*, KINB., Hawai.
(9) *Megascolex antarcticus*, BAIRD, New Zealand.

As to the first of these species, it is stated to have a clitellum of five segments beginning with the thirteenth; this suggests *Megascolex* rather than *Perichaeta*, but there is no certainty that the worm belongs to either genus; it may possibly be a *Perionyx* for instance.

Pheretima californica should be, from its habitat, a true *Perichaeta*, for, according to our present knowledge, no Perichaetidae except *Perichaeta* (s.s.) live in America; but, if we are to trust KINBERG'S description of the clitellum as consisting of four segments, its reference to *Perichaeta* is less likely. The species too is remarkable for its occurrence on the sea-shore near San Francisco. I am disposed to think that it may prove to be another genus altogether.

Lampito mauritii has also a clitellum of four segments; it may possibly be identical with my *Perichaeta mauritiana*, in which case there will be an error on KINBERG'S part in the enumeration of the segments of the clitellum.

Megascolex lineatus of HUTTON is too small to be my *Diporochaeta intermedia;* but there is no reason why it should not be congeneric with that species, or, for the matter of that, why it should be. The genus cannot be fixed with certainty.

Perichaeta coerulea of PERRIER is altered by VAILLANT (6, p. 71) to *Megascolex perrieri*, on the grounds that we have already *M. coeruleus* of TEMPLETON; as, however, I have shown that the latter=*P. leucocycla* of SCHMARDA, there would be no need for a change were *P. coerulea* recognizable. As, however, *P. coerulea* is too imperfectly described, it must be for the present excluded from a systematic revision of the group. The only positive fact given about it is that the oviducal pores are paired, and that the setae are equidistant; the first fact suggests *Megascolex*, the second *Perichaeta*.

Perichaeta luzonica has a ventral gap bordered by larger setae. It might be my *P. acystis*, but the data are not sufficient to refer it without doubt to the genus *Perichaeta*.

Megascolex sylvestris of HUTTON (1) may be congeneric or even identical with BENHAM'S *Plagiochaeta.* I have entered into this question below.

Perichaeta corticis is said to have 40 setae *per* segment, of unequal dimensions, to be 60 mm. long, and to be composed of 114 segments. As VAILLANT (6, p. 88) justly remarks, these characters are not enough to allow of our forming an idea of the relations of this species.

Megascolex antarcticus of BAIRD (3) has also been examined by myself (61) as regards external characters. The occurrence of a median genital papilla upon each of segments xvii and xix seems to distinguish the species; but there are no data as to the genus. I therefore leave it *incertae sedis.*

Genus MEGASCOLEX, TEMPLETON.

Syn. **Perichaeta,** AUCT. (in part.).
Anisochaeta, BEDDARD.

DEFINITION. **Perichaetidae, with circles of setae interrupted in the middle dorsal and ventral lines, sometimes much fewer on anterior segments; clitellum generally occupying more than three segments. Gizzard in segment V or VI. No intestinal caeca. Spermiducal glands lobate; penial setae occasionally present. Oviducal pores double.**

I have already gone into the history of this genus, which has been a somewhat confused one. It remains now to review the species which are here referred to it. There is not a great deal of variation in the genus. The most aberrant type is, perhaps, *M. ceylonicus*, whose position in the system is doubtless a little dubious. It is very characteristic of this genus that, in addition to the diffuse nephridia, there should be a series of larger paired nephridia; this occurs, for example, in *M. armatus;* nothing of the kind has ever been met with in the true *Perichaeta.* I refer (provisionally) one species to this genus, which has paired nephridia only; this worm, *M. dendyi*, may prove to be a *Perionyx.* It is possible also that the activity which is found in all the species belonging to the genus *Perichaeta* (s. s.) is limited to that genus; the only species of *Megascolex* which I have had the opportunity of seeing in the living condition is *M. armatus;* in this species there was not that sprightliness which I have seen in *Perichaetae.* The setae too in *Megascolex* are not set upon ridges as in *Perichaeta;* in consequence, when the worms are handled the setae are not so evident to the feel.

This genus is characteristically Australian in distribution; it extends, however, into the Oriental region, having been found in India, Ceylon, and many of the islands of the Indian archipelago; its comparatively limited distribution contrasts with that of its ally *Perichaeta*, whose range is practically world-wide.

I allow 39 species as sufficiently defined; in addition to these there are a few others which have not been, as yet, adequately described; these are contained in BOURNE's preliminary list of Indian earthworms.

He describes five species which appear to me to be referable to *Megascolex*; these are *P. bivaginata*, *P. lawsoni*, *P. gracilis*, *P. hulikalensis*, and *P. salettensis*. Of these *P. salettensis* and *P. bivaginata* are probably identical with my *M. armatus*. I am informed by BOURNE that this is the case. I refer *P. lawsoni* to the genus on account of the fact that it has a clitellum extending over four segments, no intestinal caeca, gizzard in vi, penial setae, and, finally, since the ordinary setae are absent between the male pores. *P. gracilis* is, in my opinion, a *Megascolex*, for some, though not all, of the same reasons:—it has an extensive clitellum, paired oviducal pores, no setae between male pores, and a gizzard in segment v. It is not, however, possible to regard the species as fully established in the light of our present knowledge of the species which belong to this genus; at the time when this preliminary account was published, FLETCHER's series of papers upon Australian earthworms was not complete; hence certain characters requisite to define these forms, and to separate them from some of those described by FLETCHER are not given by BOURNE.

Several species belonging to the genus, which I extend for their inclusion, have only eight setae on the first few segments. The same character occurs in some species of the genus *Diporochaeta*.

Three species, viz. *M. margaritaceus*, *M. iris*, and *M. pictus*, form a group which is really intermediate between *Perichaeta* and *Megascolex*, as will be seen from the descriptions of these species which follow. It is very doubtful indeed whether they are rightly assigned to the present genus. The principal reason which leads me to place them therein is the extensive clitellum and the dorsal gap in the line of setae. Other intermediate forms are to be found among the Australian species described by FLETCHER and SPENCER. Thus *M. indissimilis* has its clitellum limited to segments xiv–xvi; so too has *M. australis*. The occasional presence of only one instead of two oviducal pores is, perhaps, rather to be looked upon as evidence of the close relationship of the genera *Megascolex* and *Perichaeta*, than to be made much of to emphasize the 'intermediate' character of any particular species.

In the following description of species it must be also understood that the gizzard occupies the fifth segment unless it is otherwise stated, and that the spermathecae have a single diverticulum.

For convenience in identification the species may be roughly classified thus:—

Spermathecae in vii–ix .	*M. stirlingi* *M. canaliculatus* *M. gracilis*	sperm-sacs in xi, xii.
	M. iris *M. margaritaceus*	gizzard in viii–ix.

	M. armatus *M. madagascariensis*	spermathecae with two diverticula.
	M. lateralis	sperm-sacs in ix, xi, xii.
	M. austrinus *M. wilsonianus* *M. raymondianus* *M. macquariensis* *M. hamiltoni*	sperm-sacs in ix, xii.
Spermathecae in viii . .	*M. exiguus*	
Spermathecae in viii, ix	*M. australis* *M. monticola* *M. indissimilis* *M. macleayi* *M. tenax* *M. newcombii*	sperm-sacs in ix, xii.
	M. coeruleus	
	M. fielderi	sperm-sacs in xii.
	M. coxii *M. attenuatus* *M. enormis*	setae eight in number in anterior segments.
Spermathecae in vi–ix .	*M. fecundus*	last heart in xii.
	M. dorsalis	last heart in xiii.
	M. pictus	gizzard in viii, ix.
	M. dendyi	paired nephridia.
Spermathecae in ix . . .	*M. cingulatus*	
	M. ceylonicus	two pairs of spermiducal glands.
Spermathecae in v–ix . .	*M. goonmurk* *M. frosti*	dorsal vessel double.
	M. sylvaticus *M. hoggii* *M. hallii* *M. ruber* *M. frenchi* *M. steeli*	sperm-sacs in ix, xii.

(1) Megascolex stirlingi (Fletcher).

Perichaeta stirlingi, Fletcher, Proc. Linn. Soc. N. S. W. (2), vol. ii, 1887, p. 395.

Definition. *Length,* 220 *mm.; breadth,* 10 *mm.; number of segments,* 200. *Clitellum XIII–XVII. Setae,* 20–40 ; *fewest anteriorly. Genital papillae: a pair on XVI/XVII–XXIII/XXIV; the anterior pair closer together than those further back. First dorsal pore, IV/V. Calciferous glands, globular diverticula in VIII–XIV; intestine begins in XVIII. First septum, IV/V; VI/XIV thickened. Last pair of hearts in XIII. Sperm-sacs in XI, XII. Egg-sacs in XIII, XIV, the latter smaller. Spermathecae in VII–IX, opening in line with setae* 4/5 *or* 5/6, *with short, club-shaped caecum. Spermiducal glands, 'long, narrow, rather flat,' with long or short genital duct. Hab.—Adelaide, N. S. Wales.*

The oviducal pore is described as being single. See also Fletcher (**6**).

(2) Megascolex raymondianus (Fletcher).

Perichaeta raymondiana, Fletcher, ibid., p. 398.

Definition. *Length,* 260 *mm.; breadth,* 9 *mm.; number of segments,* 135. *Clitellum, XIII–XVII. Setae,* 28, *increasing posteriorly to* 36, *on anterior segments twice as long as in posterior. Genital papillae ellipsoidal on ventral line of XVII, XVIII. First dorsal pore, V/VI. Septa VI/XV thickened. Other characters as in* M. austrinus. *Hab.—Raymond Terrace, Hunter River, N. S. Wales.*

(3) Megascolex hamiltoni (Fletcher).

Perichaeta hamiltoni, Fletcher, ibid., p. 399.

Definition. *Length,* 143 *mm.; breadth,* 5 *mm.; number of segments,* 148. *Setae twice as long anteriorly,* 16 *in first setigerous segment behind clitellum,* 28–36. *Genital papillae as a swelling on ventral surface of XVII–XIX, also papillae with pores on XVII, XVIII. Other characters as in* M. austrinus. *Hab.—Guntawang, N. S. Wales.*

(4) Megascolex exiguus (Fletcher).

Perichaeta exigua, Fletcher, ibid., p. 387.

Definition. *Length,* 60 *mm.; breadth* 3·5 *mm.; number of segments,* 115. *Clitellum, XIV–XVII. Setae,* 20–30. *Male pores on line with third seta. Genital papillae: ventral thickenings on X, XI; on some or all of segments XVI, XVII, XIX, XX, paired*

papillae. First dorsal pore, V/VI. Calciferous glands in (IX) X–XIII; intestine begins in XVI. Last pair of hearts in XII. Sperm-sacs in IX–XII. Spermathecae in VIII; caecum half as large as pouch. Hab.—Springwood; Manly; Randwick, N. S. Wales.

Of this species FLETCHER describes a variety, termed by him '*Murrayana*.' This differs from the type-form in a number of characters: (1) caeca much longer than pouch, and filiform instead of club-shaped; (2) sperm-sacs in ix, xii, instead of xi, xii: (3) spermiducal glands narrower, less incised; and the genital ducts shorter, thicker, and less markedly bent in horse-shoe fashion. There seem also to be slight differences in the papillae; but, as these not only differ in individuals of the type-form, but also in individuals of the variety, they are not described by FLETCHER.

(5) Megascolex australis (FLETCHER).

Perichaeta australis, FLETCHER, ibid. (2), vol. i, 1886, p. 561.

Definition, *Length,* 144 *mm.; breadth,* 9 *mm.; number of segments,* 140. *Clitellum, XIV–XVI, with setae. Setae,* 20–36. *No genital papillae. First dorsal pore, V/VI. Gizzard in VI; calciferous glands in X–XII; intestine begins in XVI. Last hearts in XII. Sperm-sacs on IX, XII. Spermathecae in VIII, IX, with caecum as long as pouch. Spermiducal glands with* U-*shaped duct. Hab.—Burrawang, Sydney, N. S. Wales.*

A supposed variety of this species from Mt. Wilson proves to be a new species (see below, *M. monticola*).

(6) Megascolex monticola (FLETCHER).

Perichaeta monticola, FLETCHER, ibid. (2), vol. ii, 1887, p. 390.

Definition. *Length,* 155 *mm.; breadth,* 7 *mm.; number of segments,* 151. *Clitellum, XIII–XVII, with setae. Setae,* 16 *on segments II–XIII;* 28–36, *or even* 50, *posteriorly. Genital papillae: 'a pair of slit-like depressions on a swollen area in the line of setae, but in the interval devoid of them on the ventral surface of IX; a pair of* 8-*like swollen masses on ventral surface of X, with four depressions, perhaps pores; on the flattened ventral surface of XVII, a pair of pores ventral of the innermost setae; a second pair on small papillae, just ventral of the papillae carrying the male pores; a third pair on minute papillae on XIX, in front of the line of setae, and corresponding with the interval between the first and second setae, first dorsal pore, V/VI. Gizzard in VI; calciferous gland in X/XIII; intestine begins in XVI. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in VIII, IX, opening ventral of first row of setae. Hab.—Mt. Wilson, N. S. Wales.*

(7) **Megascolex (?) canaliculatus** (Fletcher).

Perichaeta canaliculata, Fletcher, ibid., p. 391.

Definition. *Length, 145 mm.; breadth, 8 mm.; number of segments, 160. Clitellum, XIII–XIX. Setae, 16. No genital papillae. Dorsal pores, V/VI. Gizzard in VI; calciferous glands not very distinct in IX–XV; intestine commences in XVII, spirally coiled. First septum, IV/V; septa VII/XV thickened. Last heart in XII. Sperm-sacs in XI, XII; sperm-reservoirs in X, XI. Spermathecae in VII/IX opening at fifth seta, with short, club-shaped caecum. Hab.—Mossman River, N. Queensland.*

This species seems from Fletcher's description to have a spermiducal gland on the plan of that of *M. cingulatus;* but it is not quite certain. The nephridia are stated to be paired structures; there may, however, as in *M. armatus*, be a pair of large nephridia besides the smaller tubules. A pair of what seem to be egg-sacs are described by Fletcher in segment xiii. They would appear to be unusually large; they contained 'granules, granular cells, and encysted parasites.' I leave it in *Megascolex* for the present until the matter of the nephridia is settled.

(8) **Megascolex wilsonianus** (Fletcher).

Perichaeta wilsoniana, Fletcher, ibid., p. 400.

Definition. *Length, 94 mm.; breadth, 4 mm.; number of segments, 120. Clitellum XIV–XVII (XVIII, XIX, XX). Setae, 20–28. Genital papillae, two pairs on XVIII, and one pair on XVII and XIX. Other characters as in* M. austrinus, *save that there is an additional pair of calciferous glands. Hab.—Mt. Wilson.*

(9) **Megascolex fecundus** (Fletcher).

Perichaeta fecunda, Fletcher, ibid., p. 401.

Definition. *Length, 65 mm.; breadth, 3·5 mm.; number of segments, 115. Clitellum, XIII–XVII. Setae, 20–24 in front of clitellum, 28–30 behind it. Genital papillae on X, XI, XVII–XXI. First dorsal pore, IV/V. Calciferous glands in X–XIV; intestine begins in XVI. Last pair of hearts in XII. Sperm-sacs in IX, XII; spermathecae in VI–IX, with diverticulum of same length as pouch-opening slightly dorsal of seta 2. Spermiducal glands 'two, in XVIII, XIX.' Hab.—Mt. Wilson, Lawson, N. S. Wales.*

The second of the two papers [6] upon this species deals with what Fletcher deems a variety, to which, however, a distinct name is not given; it differs from

the type in having only two pairs of spermathecae in viii, ix; there is an additional 'raised area' on xvi.

(10) Megascolex indissimilis (FLETCHER).

Perichaeta indissimilis, FLETCHER, ibid. (2), vol. iii, p. 1550.

Definition. *Length*, 110 *mm.; breadth*, 3 *mm.; number of segments*, 110. *Clitellum, XIV–XVI. Setae*, 20–24 *in front of the clitellum*, 26–30 *behind. Genital papillae on VII–X, XVII, XIX–XXIII. First dorsal pore, IV–V. Calciferous glands, X–XII. Sperm-sacs in IX, XII. Spermathecae usually two pairs in VIII, IX (one or two additional pairs sometimes present), with caeca as long as pouch. Hab.—Shores of Lake Alexandria, South Australia.*

(11) Megascolex macleayi (FLETCHER).

Perichaeta macleayi, FLETCHER, ibid., p. 1556.

Definition. *Length*, 90 *mm.; breadth*, 4·5 *mm.; number of segments*, 90. *Clitellum, XIII–XVII. Setae*, 20–28. *Genital setae, a pair on XVII, XIX; a pair of 'swellings' on X, XI. First dorsal pore, V–VI. Two pairs of calciferous glands in XI, XII. Other characters as in* M. australis. *Hab.—Sydney.*

Besides the type specimens of which the above is a description, FLETCHER subsequently [6] received others from Mount Wilson, Lawson, Burrawang, Mount Victoria, Raymond Terrace and Morpeth, Coonabarabran.

These showed slight differences, to which, however, names have not been given. The only differences concern the measurements and the arrangement of the genital papillae; there are frequently papillae upon xvi and upon xx and xxi.

12) Megascolex dorsalis (FLETCHER).

Perichaeta dorsalis, FLETCHER, ibid. (2), vol. ii, p. 618.

Definition. *Length*, 192 *mm.; breadth*, 7 *mm.; number of segments*, 135. *Clitellum, XIV–XVII. Setae*, 16–30. *Dorsal pores commence, IV–V. Genital papillae paired on X, XVII. Gizzard in V (or VI?); from VIII–XIV globular calciferous glands; intestine begins in XVII. Last pair of hearts in XIII. Septa VIII–XIV thickened. Sperm-sacs in IX, XI, XII. Egg-sacs in XIII, XIV. Spermathecae in VI–IX, opening in line with seta* 8 *or* 10, *with caecum longer than pouch. Spermiducal glands with long ʃ-shaped duct (eversible). Hab.—Eltham, Gippsland, Victoria.*

In this species the oviducal pore, as in *M. stirlingi*, is single and median. Of

this species FLETCHER has given a short description of the cocoon (see p. 6). The largest specimens came from Eltham, and in these there were no copulatory structures on segments x, xi (i)[1].

(13) Megascolex tenax (FLETCHER).

Perichaeta tenax, FLETCHER, ibid. (2), vol. i, 1886, p. 953.

Definition. *Length,* 157 *mm.; breadth,* 6 *mm.; number of segments,* 150. *Clitellum, XIII–XVII, with setae. Setae,* 36–60. *Male pores in line with seta* 2. *Genital papillae four on each of segments IX, X, a pair sometimes also on XI, on XVII, XIX a pair of circular depressions, a single one on XVIII. Dorsal pores begin IV, V. Calciferous glands in XI–XIII; intestine begins in XVI. Septa VII/XIV thickened. Dorsal vessel shows indications of being double in parts; hearts in X–XII. Sperm-sacs in IX, XII. Spermathecae in VIII, IX, opening in line with seta* 2 *or* 3, *caecum short. Hab.—Auburn, near Paramatta, Cumberland County, Springwood Blue Mts., N. S. Wales.*

See also FLETCHER **(6)**.

(14) Megascolex austrinus (FLETCHER).

Perichaeta austrina, FLETCHER, ibid., p. 956.

Definition. *Length,* 90 *mm.; breadth,* 5 *mm.; number of segments,* 128. *Clitellum, XIV–XVII. Setae,* 16 *in front of clitellum,* 20–40 *behind. Genital papillae on IX, XXVII, XIX. Spermathecae in VII–IX, opening in line with seta* 2, *caecum long. Other characters as in* M. australis. *Hab.—Burrawang, N. S. Wales.*

(15) Megascolex gracilis (FLETCHER).

Perichaeta gracilis, FLETCHER, ibid, p. 958.

Definition. *Length,* 110 *mm.; breadth,* 4–6 *mm.; number of segments,* 155. *Clitellum, XIII–XVI. Setae,* 20–24. *Genital papillae single in XVI/XVII–XVIII/XIX, and a pore in middle of XVIII. First dorsal pore, V/VI. Gizzard in VI; globular glands in XII–XV; intestine begins in XVII. Sperm-sacs in XI, XII. Last heart in XII. Spermathecae in VII–IX, opening in line with seta* 4 *or* 5, *with long caecum. Spermiducal glands long, reaching from XVIII–XXIV, duct* U-*shaped. Hab.—Auburn, near Paramatta.*

FLETCHER states that the oviducal pores are paired at the end of his description, but that there is a single pore at the beginning (p. 959).

[1] Nothing is said about segment xi in the original description.

(16) Megascolex macquariensis (FLETCHER).

Perichaeta macquariensis, FLETCHER, ibid. (2), vol. iv, 1889, p. 1000.

Definition. *Length,* 180 *mm.; breadth,* 7 *mm.; number of segments,* 200. *Clitellum, XIV–XVII. Setae,* 18 *or* 16 *to* 44, *larger anteriorly. Genital papillae on XVII–XIX, paired, on X, XI (XII) also. First dorsal pore, III/IV. Calciferous pouches in X–XIII. Last hearts in XIII. Penial setae present. Other characters as in* M. **austrinus.** *Hab.—Dubbo, N. S. Wales, from banks of Macquarie.*

(17) Megascolex newcombei (BEDDARD).

Perichaeta newcombei, BEDDARD, P. R. Soc. Edin. vol. xiv, 1887, p. 170.

Definition. *Length, about* 3 *in. Setae with only the faintest trace of a gap dorsally. Clitellum, XIV–XVI, with setae. Oviducal pore single. Genital papillae very numerous; a single papilla upon segments VII, VIII, XIII; four papillae upon IX, X; three upon XI, XII, XVII, XX, XXI; on XVIII one in front of and one behind the male pore on each side, and on XIX the same number with an identical arrangement. Gizzard in VI; dilatations of the oesophagus in X–XII. Spermathecae in VIII, IX with a single diverticulum. Sperm-sacs in IX–XII. Hab.—Queensland.*

(18) Megascolex goonmurk (SPENCER).

Perichaeta goonmurk, SPENCER, P. R. Soc. Vict., 1892, p. 21.

Definition. *Length,* 110 *mm.; number of segments,* 150. *Clitellum, XIII–XIX. Setae,* 8 *on I,* 10 *on II,* 12 *up to clitellum,* 16 *after clitellum. Median papillae on XVII/XVIII, XVIII/XIX. No calciferous glands, but swellings in VIII–XIV. Intestine begins in XVI. Dorsal vessel double; supra-intestinal double. Last heart in XI. Sperm-sacs in XII. Spermathecae in V–IX. Hab.—Mt. Goonmurk, Victoria.*

(19) Megascolex sylvaticus (SPENCER).

Perichaeta sylvatica, SPENCER, ibid., p. 5.

Definition. *Length,* 75 *mm.; number of segments,* 100. *Clitellum, XIII–XVII. Setae,* 20–24. *Genital papillae, XVI/XVII. Calciferous glands in X–XII; intestine begins in XV. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in V–IX. Hab.—Fern-tree Gully, Victoria.*

(20) Megascolex hoggii (Spencer).

Perichaeta hoggii, Spencer, ibid., p. 6.

Definition. *Length,* 120 *mm.; number of segments,* 125. *Clitellum, XIII–XVII. Setae,* 24–32. *Genital papillae, three pairs on IX–XI, on IX/X an additional pair. Calciferous glands in X–XII; intestine begins in XVII. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in V–IX. Hab.—Castlemain, Victoria.*

(21) Megascolex rubra (Spencer).

Perichaeta rubra, Spencer, ibid., p. 8.

Definition. *Length,* 55 *mm.; number of segments,* 90. *Clitellum, XIV–XVI. Setae,* 20–24. *Genital papillae on V–IX, gradually becoming paired from in front backwards, median longer papillae on XVII, XIX–XXIII. Calciferous glands in X–XII; intestine begins in XV. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in V–IX. Hab.—Tallarook, Victoria.*

(22) Megascolex frenchii (Spencer).

Perichaeta frenchii, Spencer, ibid., p. 9.

Definition. *Length,* 100 *mm.; number of segments,* 110. *Clitellum, XIII–XVII. Setae,* 20–24. *Genital papillae median on IX, X, XIX–XXII. Calciferous glands in X–XII; intestine begins in XV. Last heart in XII. Sperm-sacs in IX–XII. Spermathecae in V–IX. Hab.—Loch, S. Gippsland, and Waratah Bay.*

(23) Megascolex steelii (Spencer).

Perichaeta steelii, Spencer, ibid., p. 10.

Definition. *Length,* 60 *mm.; number of segments,* 120. *Clitellum, XIV–XVI. Setae,* 20–24. *Genital papillae median on XVII. Calciferous glands in X–XII; intestine begins in XV. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in V–IX. Hab.—Woodend, Victoria.*

(24) Megascolex fielderi (Spencer).

Perichaeta fielderi, Spencer, ibid., p. 19.

Definition. *Length,* 150 *mm.; number of segments? Clitellum, XIII–XVIII. Setae,* 12 *on all segments. Genital papillae median XIX/XX, XX/XXI. Vascular swellings in XI,*

XII; calciferous glands in XIII; intestine begins in XVII. Last heart in XIII. Sperm-sacs in XII. Spermathecae in VIII, IX. Hab.—Narre Warren, Fern-tree Gully, and Sassafras Gully.

This species is remarkable for its colour, which is described by SPENCER as being 'cream-coloured, with a thick, bright pink-coloured clitellum.' Its general appearance is said to be that of a *Megascolides*. There appears to be only a single pair of testes and funnels. The existence of peptonephridia is stated; one of the interesting points in its structure seems to be the presence of vascular swellings as well as true calciferous glands. It has also penial setae.

(25) Megascolex frosti (SPENCER).

Perichaeta frosti, SPENCER, ibid., p. 20.

Definition. *Length,* 120 *mm.; number of segments,* 220. *Clitellum, XIV–XVII. Calciferous glands in VIII–X; vascular swellings in XI–XIII; intestine begins in XV. Dorsal vessel partly double. Last heart in XIII. Sperm-sacs in XII (and XIII?). Spermathecae in V–IX. Hab.—Croajingalo.*

This species is much like the last in general appearance; it has also single testes. The spermiducal glands are bilobed as in certain Cryptodrilids. The setae were invisible.

(26) Megascolex lateralis (SPENCER).

Perichaeta lateralis, SPENCER, ibid., p. 11.

Definition. *Length,* 90 *mm.; number of segments,* 126. *Clitellum, XIV–XVI. Setae,* 20–24. *Genital papillae, a pair close to male pores and a pair on XVIII/XIX, XIX/XX, IX/X. Vascular swellings in IX/XII; intestine begins in XVII. Last heart in XII. Sperm-sacs in IX, XI, XII. Spermathecae in VII–IX. Hab.—Castlemain, Tallarook, Victoria.*

(27) Megascolex dendyi (SPENCER).

Perichaeta dendyi, SPENCER, ibid., p. 12.

Definition. *Length,* 60 *mm.; number of segments,* 160. *Prostomium complete. Clitellum, XIV–XVI. Setae,* 12 *up to segment XIX, thence increasing to* 20. *Genital papillae paired on VIII/IX, IX/X (surrounding apertures of spermathecae), XVII/XVIII, XIX/XX, XX/XXI, median on XVIII/XIX. Oesophageal swellings in IX–XII; intestine begins in XVIII. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in VI–IX. Hab.—Healesville, Victoria.*

This species is quite exceptional in the genus *Megascolex* in having paired nephridia. It may prove to be rather referable to *Perionyx*, which is chiefly to be characterized by its paired nephridia and lobate spermiducal glands.

(28) Megascolex coxii (Fletcher).

Perichaeta coxii, Fletcher, Proc. Linn. Soc. N. S. Wales (2), vol. i, 1886, p. 565.

Definition. *Length*, 190 *mm.; diameter*, 9 *mm. Setae as many as* 50 *per segment posteriorly. Clitellum*, *XIII–XVII. Dorsal pores commence XIII/XIV. Eight pairs of genital pores on segments in front of and behind the eighteenth. Calciferous glands*, 6 *pairs in VIII–XIII. Last heart in XIII. Sperm-sacs in XI, XII. Spermathecae in VIII, IX, with short caecum. Spermiducal glands extend through nine segments. Hab.—Mt. Wilson, N. S. Wales.*

See also Fletcher (5).

(29) Megascolex attenuata (Fletcher).

Perichaeta attenuata, Fletcher, ibid. (2), vol. iii, 1888, p. 1552.

Definition. *Length*, 100 *mm.; diameter*, 3 *mm.; number of segments*, 220. *Setae*, 28 *per segment in posterior fourth of body. Clitellum*, *XIII–XVII. Male pores on XVII. Dorsal pores commence XII/XIII. Calciferous pouches, six pairs in VIII–XIII. Last hearts in XII. Sperm-sacs in IX, XII. Spermathecae in VIII, IX; pyriform pouches, with a single, club-shaped caecum. Spermiducal glands extend through three segments. Hab.—Mt. Wilson, Australia.*

(30) Megascolex enormis (Fletcher).

Perichaeta enormis, Fletcher, ibid., p. 1555.

Definition. *Length*, 87 *mm.; diameter*, 4 *mm.; number of segments*, 220. *Setae not more than* 16 *per segment in posterior region of body. Dorsal pores commence X/XI. Male pores XVII/XVIII; between each two segments from XV/XXII a pair of genital papillae. Spermathecae (in VIII, IX?) each with two small caeca. Hab.—Near Gosford, N. S. Wales.*

The setae appear to be sinuously arranged on the posterior segments of the body; sometimes 'they alternate irregularly for some distance.' Along with this peculiarity, to which I have referred above in the sketch of the genus, is another, viz., that the setae are implanted on conspicuous ridges, 'giving the body a more *perichaete* appearance.'

(31) **Megascolex cingulatus** (SCHMARDA).

Perichaeta cingulata, SCHMARDA, Neue wirbell. Thiere, Bd. I, ii, p. 14.
Non-Perichaeta cingulata, VAILLANT, Ann. Sci. Nat., 1868, p. 225.
Non-Megascolex cingulatus, VAILLANT, Annelés, p. 72.
M. cingulatus, BEDDARD, Ann. and Mag. Nat. Hist., Feb. 1892, p. 122.

Definition. *Length, 130 mm.; breadth, 6 mm.; number of segments, 100. Colour, a greyish red. Clitellum, XIII–XVII; setae present on all the segments of clitellum; a complete row on XIII, six setae on each of segments XIV–XVI, ten or twelve setae upon XVII. Dorsal pores commence V/VI. No setae between genital pores on segment XVIII; two pairs of papillae in intersegmental furrows, XVII/XVIII, XVIII/XIX. Gizzard in VI, VII, the septum between these segments being present; intestine begins in XV. Septa VII/XII, thickened. Spermiducal glands long and rather narrow, but lobate; the duct arises from the end of the gland, and is long and coiled. Penial setae present; they are bent at extremity, and ornamented for a short distance with minute denticulations. Sperm-sacs in X, XI. Spermathecae, one pair in IX; the oval diverticulum—one-third of the length of the pouch—has two subsidiary diverticula, each terminating in two swollen extremities. Hab.—Ceylon.*

This species was originally and very imperfectly described by SCHMARDA, who figured the living worm and the seta (Pl. xviii, fig. 162, and woodcut on p. 14); in the text the clitellum is said to commence with the thirteenth segment, but it is figured as beginning at segment xv. The species was redescribed by myself (**28**, p. 122) from SCHMARDA'S type. Without a re-examination of the type it would be quite impossible to determine the position and affinities of the species, and there has been, in consequence, a considerable confusion in the literature relating to it. VAILLANT (**3**) discovered in the Museum at Paris some worms which were 'very evidently' *P. cingulata;* the identification could hardly have rested upon more than the existence of the numerous setae in each segment; for there is nothing in SCHMARDA'S description that fits in with the characters of any of the several species which PERRIER (**3**) found that VAILLANT had united under the name of '*P. cingulata.*'

In my account of the species I have figured the spermatheca (figs. 10, 11), the spermiducal gland (fig. 12), the external characters of the clitellar segments seen on their ventral aspect (fig. 9), and the penial seta (fig. 13).

(32) **Megascolex brachycyclus** (SCHMARDA).

Perichaeta brachycycla, SCHMARDA, Neue wirbell. Thiere, Bd. I, ii, p. 14.
M. brachycyclus, VAILLANT, Annelés, p. 88.

Definition. *Length,* 80 *mm.; breadth,* 3 *mm. First dorsal pore, V/VI. Oviducal pores double. Genital papillae, XVII/XVIII and XVIII/XIX, in front of and behind male pores. Hab.—Ceylon.*

SCHMARDA relied principally upon the form of the setae to distinguish this species from the last. It is not however safe, in the present state of our knowledge, to use this as a character. SCHMARDA'S type was afterwards examined by myself, but I could detect hardly any differences between it and *M. cingulatus.* I was not able, however, to study the internal anatomy. As, however, there are colour differences, it is perhaps legitimate to retain it, at least provisionally, as a distinct form. It appeared to me that the dorsal and ventral gaps in the setae were not quite so well marked as in *M. cingulatus,* and that the genital papillae were not so exactly in line with the genital orifices.

(33) Megascolex iris, MICHAELSEN.

M. iris, MICHAELSEN, Arch. f. Nat., 1892, p. 244.

Definition. *Length,* 240 *mm.; breadth,* 9 *mm.; number of segments,* 240. *Setae with a dorsal, but without a ventral, interruption; the ventral setae are small and closer together than the more dorsally placed setae, which are at the same time larger. Clitellum, $\overline{XIII–XVII}$. Dorsal pores commence XII/XIII. Male pores close together on XVIII; genital papillae two pairs on the intersegmental furrows XIX/XX, XX/XXI, close to median ventral line. Oviducal pore single and median upon XIV. Gizzard in VIII–X (?). Three pairs of spermathecae in VII–IX; each with a single diverticulum. Hab.—Samar, Loquilocun.*

This species is not so satisfactorily proved to be a *Megascolex* as are some others; the median oviducal pore is a character of *Perichaeta,* though the fact that in *M. coeruleus* this pore is sometimes single and median must be borne in mind. The position of the gizzard is that of *Perichaeta;* the query as to its segments in the above description is, it should be remarked, that of MICHAELSEN; this applies also to the following species.

(34) Megascolex margaritaceus, MICHAELSEN.

M. margaritaceus, MICHAELSEN, ibid., p. 245.

Definition. *Length,* 90 *mm.; breadth,* 5 *mm.; number of segments,* 10. *The setae are larger and further apart dorsally than ventrally; there were* 25 *on a segment of the anteclitellian region. Clitellum, $\overline{XIII–XVII}$. Genital papillae closely applied pairs upon the intersegmental furrows, IX/X, X/XI, XII/XIII, XVIII/XIX, XIX/XX. Gizzard in VIII–X (?).*

Three pairs of spermathecae in VII–IX; the single diverticulum longer than in the last species. Hab.—Samar, Loquilocun.

(35) Megascolex pictus, MICHAELSEN.

M. pictus, MICHAELSEN, ibid., p. 246.

Definition. *Length, 240 mm.; breadth, 9 mm.; number of segments, 137. There are as many as 80 setae in a row; the ventral setac are closer together than the dorsal. Dorsal pores, XII/XIII. Clitellum, XIII–XVIII. Between male pores are 19 setae. Gizzard in IX, X (?). Spermathecae four pairs in VI–IX; each has a single diverticulum. Hab.—Borneo; Sampit.*

It is doubtful whether this species ought not to be referred to *Perichaeta*. The gizzard is apparently as in *Perichaeta*, and the segments in which it lies (queried by MICHAELSEN, not by me) are said to be 'innerlich·verschmolzen.' The occurrence of setae between the male pores is characteristic of *Perichaeta*, not of *Megascolex*.

(36) Megascolex armatus (BEDDARD).

Perichaeta armata, BEDDARD, Ann. and Mag. Nat. Hist., Oct., 1883, p. 216.
M. armatus, ROSA, Ann. Mus. Civ. Genova, vol. vii. (2a), p. 134.

Definition. *Length, 90 mm.; breadth, 4 mm.; number of segments, 170. Clitellum, XIV–XVII; setae present forming complete rings. Dorsal pores commence XI/XII. Setae about 44 per segment; on the ventral surface the setae get to be larger and separated by wider intervals. Gizzard in VI. The intestine without a typhlosole. Septa VI/XIV thickened. Last pair of hearts, XIII. Male pores furnished with a sac of penial setae; these are covcred at the extremity with numerous, rather long spinelets, the apices of which are directed towards the end of the seta. In segment XIV are a pair of egg-sacs; the spermathecae three pairs in segments VII, VIII, IX; each has two minute diverticula. Hab.—Calcutta; Burmah; Labuan (Borneo); Seychelles; Nias.*

This species appears to be the most generally diffused *Megascolex* of the East. It is quite possible that it is identical with one of the two species described by PERRIER (4) as possibly new genera of Perichaetidae, viz. *P. coerulea* and *P. luzonica; P. coerulea* is stated by PERRIER to have two oviducal pores instead of the usual one; in this particular it, of course, agrees with my *M. armatus;* in *P. luzonica* the ventral setae are larger than the others; this again is a character which is met with in *M. armatus*, and for the matter of that in other species of the genus *Megascolex;* but it also occurs in *P. houlleti*, which is a member of the genus

Perichaeta (s. s.). As, however, the details given by PERRIER of the above-mentioned species are slight, I do not include them in the list of synonyms of *M. armatus*.

(37) Megascolex ceylonicus (BEDDARD).

Perichaeta ceylonica, BEDDARD, Ann. Mag. Nat. Hist., Feb. 1886, p. 89.

Definition. *Length,* 225 *mm.; diameter,* 10 *mm. Clitellum, XIV–XVII. Setae forming continuous rows,* 51 *per segment in posterior region of body. Dorsal pores present. Last hearts in XIII. On XVIII two pairs of male pores, with no setae between them; from the posterior protrude penial setae. Two pairs of spermiducal glands correspond to these, the anterior of which are tubular, the posterior lobate. One pair of spermathecae in IX with a single diverticulum. Hab.—Ceylon.*

This species was described by myself from a single badly-preserved specimen. I have unfortunately no record of the position of the gizzard, which would be of importance in relation to its systematic position. There appeared to be no dorsal gap in the line of setae, and only a very feebly indicated ventral gap. The relations of the sperm-ducts to the spermiducal glands were not discovered; the penial setae which are connected with the second, lobate, gland, are marked near to the free extremity with a number of minutely denticulate ridges; at the very tip are a series of chevron-shaped ridges with the angle turned towards the tip. The nephridia appear to be diffuse, and no larger tufts of tubules were found, such as occasionally occur in this genus.

(38) Megascolex madagascariensis (MICHAELSEN).

Perichaeta madagascariensis, MICHAELSEN, Arch. f. Nat., 1891, p. 227.

Definition. *Length,* 80 *mm.; diameter,* 3·5 *mm.; number of segments,* 185. *Clitellum, XIII–XVIII. Oviducal pore single. Penial setae cleft at extremity, and with numerous blunt straight spines. Spermathecae in VII, VIII, IX, each with two diverticula. Hab.—Madagascar.*

This species was described by MICHAELSEN from a single poorly-preserved specimen. Hence a number of important details are necessarily wanting. The segments occupied by the clitellum are queried by MICHAELSEN. The gizzard is said to be about in the fourth segment. The species evidently comes very near to my *M. armatus*. The only differences appear to be in the single oviduct and in the form of the penial setae; the spines upon these would seem to be shorter and blunter in the present species.

(39) **Megascolex coeruleus**, TEMPLETON.

M. coeruleus, TEMPLETON, Ann. Mag. Nat. Hist., 1845, p. 60.
Perichaeta leucocycla, SCHMARDA, Neue wirbell. Thiere, I. ii., p. 13.
Pleurochaeta moseleyi, BEDDARD, Tr. Roy. Soc. Ed., 1880, p. 481.
M. moseleyi, VAILLANT, Annelés, p. 67.
M. leucocyclus, VAILLANT, ibid, p. 87.

Definition. *Length*, 32 *in.; number of segments*, 270. *Clitellum, XIII/XXI, and saddle-shaped posteriorly, with setae. Male pores ventrad of ventralmost seta of segment XVIII; between XVII/XVIII, XVIII/XIX a pair of papillae, corresponding in position which are the orifices of small white glands. Setae*, 140 *in posterior segments, only* 36 *on V. Dorsal pores commence VI/VII. Septa begin IV/V; septa VIII/XIII thickened. Gizzard in V. Calciferous glands in X–XV; intestine begins in XVII, in segments CXII–CXXXIII a series of intestinal glands. Dorsal blood-vessel double anteriorly. Spermathecae in VIII, IX, with a small caecum. Spermiducal glands small and compact. Hab.—Ceylon.*

This species has been investigated anatomically by myself (**2**) and BOURNE (**4**). The synonymy is rather complex, as the species has had no less than three names given to it on account of the imperfect descriptions of those who first dealt with its characters. I do not think that it is possible to separate from this species ROSA's *M. templetonianus.* He has, however, as yet, only published a short note of it, so it is impossible to speak positively. He distinguishes *M. coeruleus* by the absence of diverticula to the spermathecae and by its double dorsal vessel; but these characters are described differently by BOURNE and by myself, and yet we were dealing, I imagine, with the same species. More recently UDE (**4**) has dealt with *M. 'templetonianus':* he describes the spermathecae as more elongated in form than I found them in *M. coeruleus*, and with a minute diverticulum.

In *Megascolex coeruleus* the longitudinal trunks are connected by peripheral branches, which have the following arrangements: there are no direct communications between the main longitudinal trunks by means of capillary networks; the capillary networks are either intestinal or tegumentary. In the alimentary canal there are two networks, one more superficial, the other deeper. The internal network is so dense 'that it may be regarded as a blood sinus interrupted at certain spots.' The network is perfectly continuous from segment to segment, and in the typhlosolar region has a greater development of the longitudinal meshes. This network is directly connected with the dorsal vessel by means of the dorso-intestinal vessels. These latter do not commence before segment ten; in that segment and up to the thirteenth there are two

pairs of these vessels, opening, however, not into the dorsal but into the supra-intestinal vessel. In segments fourteen to sixteen there is a single pair only, which are connected (as are the hearts) with both dorsal and supra-intestinal trunks. After this segment and up to the one hundred and thirty-fifth there are two pairs in each segment, and from thence to the end of the body only one pair again. The external intestinal network is composed of capillaries not so uniform in diameter as those of the internal network, and they do not form so close a network; nor is the network continuous as such from segment to segment. Branches put the two intestinal plexuses into communication. With this network communicate the intestino-tegumentary vessels. The long anteriorly-situated intestino-tegumentary vessels have been already described among the principal longitudinal trunks of the Oligochaeta. From the fourteenth segment onwards, according to BOURNE's figures, there are a paired series (one pair to each segment) of corresponding vessels, which put the superficial intestinal network into communication with the tegumental network. They are also connected with each other, especially by a longitudinal infra-intestinal vessel.

The term Peripheral network is applied by BOURNE to the vascular plexuses in the skin and in the septa, and in fact in all the organs of the body except the alimentary trunk. These networks are connected with the intestinal by means of the intestino-tegumentary trunks already referred to, and with the dorsal and ventral blood-vessels by means of the dorso-tegumentary and ventro-tegumentary vessels. The dorso-tegumentary vessels exist in front of and behind the hearts. They also co-exist with the four posterior pairs of latero-intestinal hearts, but not with the anterior of these. There are branches, however, of the anterior hearts which may morphologically correspond to the missing dorso-integumentary vessels. The ventro-tegumentary trunks open into the ventral vessel—a pair to every vessel except the first and the eighth to the thirteenth, where are the hearts.

Megascolex has no subnervian blood-vessel.

(40) **Megascolex albidus** (MICHAELSEN).

Perichaeta albida, MICHAELSEN, Arch. f. Nat., 1892, p. 237.

Definition. *Length*, 135 *mm.; number of segments*, 110. *No pigment in skin. Setae*, 40 *per segment. Dorsal pores commence V/VI. Clitellum, XIII–XVII. One genital papilla in middle line of XVIII, and a pair on IX and two pairs on X. Gizzard in VI; septa VI/XIV thickened. Sperm-sacs in IX, XII. Spermathecae in VIII, IX, with a single diverticulum. Hab.—Marquesas.*

Genus PERICHAETA, SCHMARDA.

Syn. **Megascolex**, VAILLANT et alii (in part.).

Nitocris
Amyntas
Pheretima } KINBERG (? in part.).
Rhodopis
Lampito
Perriera, VAILLANT.

DEFINITION. **Perichaetidae with complete circles of setae. Clitellum nearly always limited to three segments. Gizzard in segments VIII, IX, the intervening mesentery being wanting; a pair of caeca nearly always present in segment XXVI. Nephridia diffuse; no penial setae. Spermiducal glands lobate.**

The majority of the species of earthworms which have been described under the names of '*Perichaeta*' or '*Megascolex*' really belong to the genus *Perichaeta* as diagnosed above.

The range of structural variation in the genus *Perichaeta* is not great. Size alone seems to distinguish a few species; thus, *P. violacea* and *P. minima* are to be distinguished by their small size, while *P. vordermanni* and *P. musica*, especially the latter, are remarkable for their large size; *P. feae* and *P. longa* are also large species. With these exceptions, the measurements of the various species are not apparently widely different.

The colours during life are known or have been described in too few species[1] for that to be used as a character of much value. The difficulty of describing colour-differences is also a bar to the use of this character.

The following points seem to be the principal ones in which the species differ; the list is drawn up from BOURNE'S remarks upon the subject (**4**) as well as from my own observations upon a considerable number of species.

(1) Number of setae upon the segments.
(2) Inequalities in size between the setae of different segments or between the setae of different regions of the same segment.
(3) The presence or absence of setae on the clitellum.
(4) The number of segments occupied by the clitellum.

[1] Only in *P. viridis* (SCHMARDA), *P. indica*, *P. morrisi*, *P. dyeri*, *P. sinensis*, *P. sumatrana* (BEDDARD).

(5) The presence or absence of genital papillae, and their number and arrangement if present.
(6) The position of the male and spermathecal pores.
(7) The position of the first dorsal pore.
(8) The number and position of the spermathecae.
(9) The relative size of the spermiducal glands, and the presence or absence of a sac at the external opening of its duct.
(10) The position and the number of specially thickened septa.

Besides these ten points in which species vary, there are a few other characters which are of less importance as they apply to only a very small number of species, perhaps only to one. Several of the Japanese species of the genus are remarkable for the rudimentary condition or the absence of the spermiducal glands; the most extreme case is that offered by *P. hilgendorfi* (=my own *P. rokugo*); in this species not a trace of the gland remains, and the pore itself is removed further back than in all other species. In two or three others the gland is reduced to the muscular duct only, the glandular part having disappeared.

Another character confined to a single species is seen in *P. stelleri*, where there are a pair of calciferous glands in the thirteenth segment. In no other *Perichaeta* are there distinct calciferous glands at all, only a particularly vascular and thickened tract of oesophagus, which probably performs the same function as the calciferous glands of other Oligochaeta. In a few forms, viz. *P. taprobanae*, *P. stelleri*, *P. everetti*, *P. sarawacensis*, *P. kinabaluensis*, and *P. neoguinensis*, there are no intestinal caeca, the presence of these being elsewhere one of the most marked peculiarities of the genus.

These same intestinal caeca afford an excellent character for distinguishing the two species *P. sieboldi* and *P. hilgendorfi*[1] from all others; in these two *Perichaetae* there is not, as in all others, a single pair of caeca, but a series of six or seven pairs lying one above the other on either side of the intestine; *P. sangirensis* appears to be unique for the existence of caeca in the fifteenth segment. MICHAELSEN, however, is not quite certain as to this matter, which is queried in his description of the species.

The number of the egg-sacs ought to have been, perhaps, included among the characters which vary in a large number of species; very little attention, however, has been paid to this matter, except by myself (**55**). There are either one or two pairs of egg-sacs; sometimes, indeed, no egg-sacs at all seem to exist; where there are two pairs, they lie in segments xiii, xiv; when there is but one pair, it is not always

[1] Occasionally also *P. musica*.

found in segment xiv, which, judging from other earthworms, would seem to be its natural position; it is, in more than one species, situated in segment xiii, just above the ovary. As has been remarked on another page (p. 86), this is, perhaps, to be accounted for by the former existence of a pair of ovaries in the twelfth segment of which traces exist in the embryos of *Lumbricus* and *Acanthodrilus*.

In the vast majority of the species of the genus *Perichaeta* there are four pairs of hearts in segments x–xiii; this is not, however, absolutely universal; in two species, *P. divergens* and *P. queenslandica*, the last pair of hearts is in segment xii. In *P. ferdinandi* this pair is, on the contrary, a segment behind that in which it usually occurs, viz. in xiv; finally, in *P. ringeana* it lies in xv.

P. vitiensis and *P. queenslandica* appear to be quite peculiar in the fact that they have only a single pair of testes and of the corresponding funnels. I am not, however, fully satisfied that my description of the former species, made upon a single individual belonging to the Vienna Museum, and, therefore, to be injured as little as possible, is correct. There is, of course, nothing improbable in the divergence from the normal, as such is constantly met with in other families of the Oligochaeta.

The only other peculiarity confined to a single species is the presence of the gizzard in *P. pentacystis* in the seventh segment.

We now come to the characters which vary greatly in the different species.

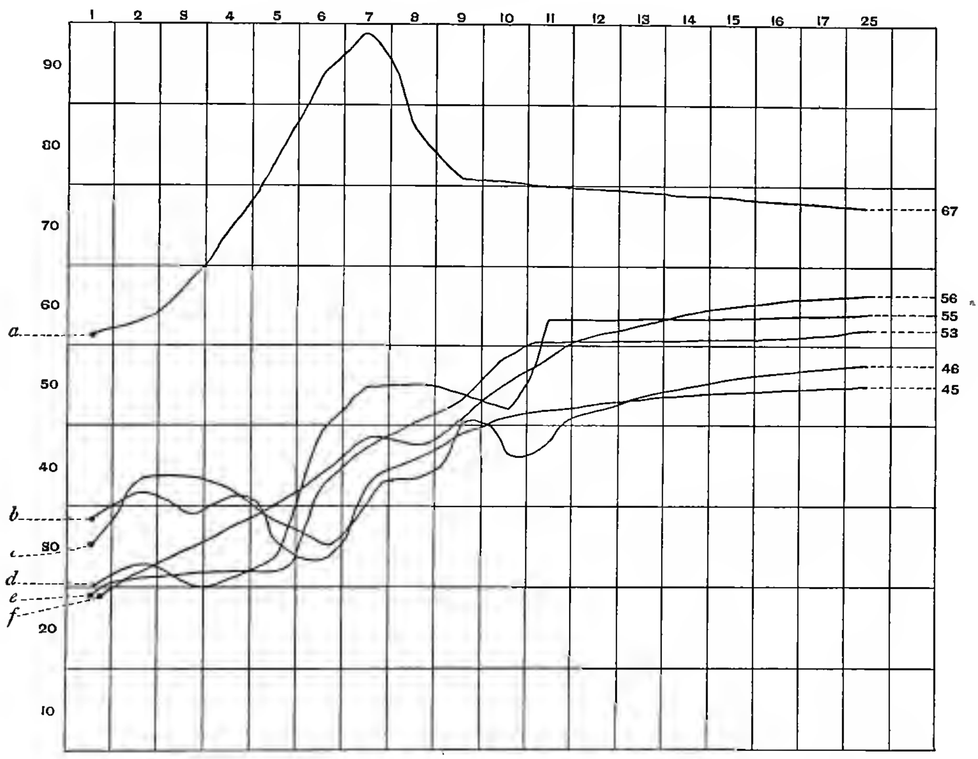
(1) The variations in the number of the setae have been noted by many observers; but they have, as a rule, contented themselves with a statement of the number of the setae in a given segment. BOURNE has directed attention to the importance of counting the setae in several segments. He found that the relation between the numbers of setae in segments v, ix, and xxv. ('the latter segment serving as a type for the rest of the body') 'varies with other important characters rather than the actual numbers themselves.' The segments used by myself (ii, vi, xiii, xxvi) do not materially differ from those used by BOURNE. Comparatively few species have been studied from this point of view. The importance which the results arrived at from a careful mapping of the setae may lead to is illustrated in the accompanying curves (p. 391); these show distinctly the difference between *P. taprobanae* and certain other species; the differences in the setae are notably confirmed by a comparison of other organs.

(2) This character is of great use in differentiating species. On the anterior segments of the body the setae are commonly larger than those upon the segments which follow; this difference has, however, been noted in but few species up to the present, and thus is not so useful as it doubtless will be. It is not uncommon to find one or more of the setae on either side of the ventral median line larger than

the others; *P. houlleti*, as I have pointed out, agrees with *P. biserialis* and *P. acystis* in this character; Horst has described the whole of the setae on the ventral side of the body in *Perichaeta* as being very large as compared with those on the dorsal side.

(3) The presence or absence of the setae on the clitellum is a matter which has been often overlooked; and yet it offers a very good character for the distinguishing

Fig. 44.



CURVES SHOWING THE NUMBER OF SETAE ON THE ANTERIOR SEGMENTS OF CERTAIN PERICHAETA.

[The segments are numbered above, the number of setae in tens on the left.]

a. *P. taprobanae.* *b.* *P. dyeri.* *c.* *P. sinensis.* *d.* *P. barbadensis.*
e. An unidentified species from Hong-Kong. *f.* *P. bermudensis.*

of species; the degree to which the setae are developed is also important; in *P. taprobanae*, for instance, the setae are present, and to the full number, on all the segments of which the clitellum is composed; in *P. indica* we have the opposite extreme; there are in this species no setae at all upon the clitellum; this statement, of course, refers to the mature worm; when the clitellum is undeveloped, the segments,

out of which it will be formed, are provided with setae just as are the other segments of the body; every intermediate condition almost occurs; thus there are species with a few setae on the ventral surface of the clitellar segments, and species in which the setae are limited to the last segment of the clitellum, &c. It is a rule, subject to only one exception, that the setae upon the clitellum are in no way different from those found elsewhere; the exception is *P. houlleti;* in this worm the clitellar setae are very short, and are bifid at the free extremity.

(4) It is a very general rule among the members of the genus *Perichaeta* that the clitellum is limited to the three segments xiv, xv, xvi. Whether it is ever less than that seems to me to be doubtful; it is true that several species, such as *P. bicincta*, have been described in which the clitellum is still further limited, and consists of the two segments xiv and xv; I have found this to occur in *P. upoluensis*. I should wish, however, to examine a large series of specimens of this and other species, in which the character has been described, before considering it to be established. As to species in which the clitellum occupies a greater number of segments than three, there is but one, unless some of the species referred to here on p. 369 as *incertae sedis* are really true *Perichaetae*. Another point of importance to be considered in describing species of *Perichaeta* is the exact way in which the clitellum terminates and commences; in some species it fully occupies the three segments xiv–xvi; in others it does not begin before about the middle of segment xiv, and it may also terminate before the end of segment xvi. In the description of the species which follows I have taken pains to indicate this peculiarity in the clitellum by placing a line above or below the number of the segment at which it commences; a line above indicates that the clitellum does not commence sharp with the commencement of the segment; a line below, that it does not end sharply with its termination. The clitellum is invariably complete, and is developed ventrally as well as dorsally.

(5) Benham (2) has grouped the members of the genus according as to whether they do or do not possess copulatory papillae; Bourne (4) has objected to this classification. No doubt it is difficult to prove a negative in the case of some species, and besides one character alone is dangerous to adopt. It will be noticed, however, in the table of the characters given on pp. 399–401 that the absence of genital papillae goes with the presence of a terminal muscular sac to the atrial duct. It is true that the converse does not invariably hold, but there is no case of a *Perichaeta* with a terminal sac to the atrium which at the same time possesses genital papillae. It is quite likely that there is some physiological relation between these structures; the absence of this eversible sac at the extremity of the atrial duct may render the papillae necessary for the two individuals to adhere to each other during coitus.

When present and everted it may be itself sufficient to hold the worms together during coitus. Another character may ultimately prove to be also related ; in no case has the clitellum any setae when the spermiducal gland opens on to the exterior by means of the sac referred to ; here again the converse is not absolutely true. Unfortunately our knowledge of the various species of *Perichaeta* is not, as yet, sufficiently advanced to permit of a definite statement upon these matters.

Though the character is an important one, it is one that must be used with caution ; it so frequently happens that a given species varies in the number of the genital papillae, that to state the typical numbers renders necessary the examination of a large number of specimens which is by no means always possible.

(6) The spermiducal pores and the spermathecal pores are sometimes nearer to and sometimes further away from the middle line.

(7) The position of the first dorsal pore is another character which must be used cautiously ; the one advantage which poorly preserved worms have over those which are well preserved is that the dorsal pores are often more obvious.

(8) In all *Perichaetae*, with the sole exception of *P. ijimae*, the spermathecae are provided with diverticula ; even *P. ijimae* may prove to be no exception when it is examined microscopically ; for in *Octochaetus multiporus* the diverticula of the spermathecae are not always apparent until the integument in the neighbourhood of the orifices of the spermathecae is examined by means of sections. The number of pairs of spermathecae offer (in conjunction with other points) very good specific characters ; it appears to be only rarely that there is any variation in individuals. In three species, however, such a variation has been recorded ; these are *P. ringeana*, *P. barbadensis*, and *P. capensis ;* in all of these the number varies from two to three pairs. One species only seems to have no spermathecae at all ; this is *P. acystis*. In two individuals of *P. acystis* I found a complete absence of spermathecae. The only other very exceptional condition of the spermatheca occurs in *P. stelleri* and a few allied forms ; here there are a large number of small spermathecae, with diverticula, in two segments. The arrangement of the spermathecae in these remarkable species is only paralleled in the Geoscolicidae. The spermathecae vary but slightly in form ; and with one doubtful exception each spermatheca has but one diverticulum ; this exception is MICHAELSEN'S species *P. ferdinandi*. In others there appear sometimes to be two or even three diverticula ; thus PERRIER mentioned the existence in *P. houlleti* of additional diverticula. I showed, however, that these supposed diverticula are really glandular appendices exactly similar to those which are often associated with the genital papillae, and have therefore only an accidental relation to the spermathecae ; 'diverticula' of this kind are found in *P. udekemi* also, a near ally of *P. houlleti*.

P. nipponica and *P. darnleiensis* are remarkable for the globular appendices of the diverticula, which do not occur in other species. The species will now be arranged in accordance with the number of spermathecae and the segments in which they occur. I leave out the few species with more than a single pair in each segment.

A. One pair of spermathecae.

(1) Spermathecae, one pair in vi (one species).

P. elongata, E. P.

(2) Spermathecae, one pair in vii (two species).

P. minima, Horst.

P. quadragenaria, E. P.

(3) Spermathecae, one pair in viii (four species).

P. taprobanae, F. E. B.

P. sangirensis, Mich.

P. pulchra, Mich.

P. vitiensis, F. E. B.

(4) Spermathecae, one pair in ix (one species).

P. racemosa, Rosa.

B. Two pairs of spermathecae.

(5) Spermathecae in vi, vii (three species).

P. hassellti, Horst.

P. morrisi, F. E. B.

P. barbadensis (in part.), F. E. B.

(6) Spermathecae in vii, viii (nine species).

P. tokioensis, F. E. B.

P. hesperidum, F. E. B.

P. mauritiana, F. E. B.

P. ferdinandi, Mich.

P. hilgendorfi, Mich.

P. japonica, Horst.

P. musica, Horst.

P. schmardae, Horst.

P. annulata, Horst.

(7) Spermathecae in viii, ix (thirteen species).

P. fasciata, Rosa.

P. grubei, Rosa.

P. novarae, ROSA.
P. longa, MICH.
P. capensis (in part.), HORST.
P. masatakae, F. E. B.
P. sluiteri, HORST.
P. forbesi, F. E. B.
P. sumatrana, HORST.
P. upoluensis, F. E. B.
P. aspergillum, E. P.
P. robusta, E. P.
P. ringeana (in part.), MICH.

C. Three pairs of spermathecae.

(8) Spermathecae in vi, vii, viii (seven species).

P. bermudensis, F. E. B.
P. barbadensis (in part.), F. E. B.
P. hawayana, ROSA.
P. ijimae, ROSA.
P. mandhorensis, MICH.
P. bournei, ROSA.
P. birmanica, ROSA.

(9) Spermathecae in vii, viii, ix (ten species).

P. aeliana, ROSA.
P. philippina, MICH.
P. sieboldi, HORST.
P. ringeana (in part.), MICH.
P. udekemi, MICH.
P. capensis (in part.), HORST.
P. houlleti. E. P.
P. dubia, HORST.
P. carinensis, ROSA.
P. peguana, ROSA.

D. Four pairs of spermathecae.

(10) Spermathecae in v, vi, vii, viii (one species).

P. queenslandica, FLETCHER.

(11) Spermathecae in vi, vii, viii, ix (fifteen species).

P. martensi, MICH.
P. divergens, MICH.
P. nipponica, F. E. B.
P. dyeri, F. E. B.
P. sinensis, F. E. B.
P. darnleiensis, FLETCHER.
P. peregrina, FLETCHER.
P. vordermanni, HORST.
P. enganensis, ROSA.
P. neoguinensis, MICH.
P. modigliani, ROSA.
P. vaillanti, F. E. B.
P. feae, ROSA.
P. indica, HORST.
P. posthuma, VAILLANT.

E. Five pairs of spermathecae.

(12) Spermathecae in v, vi, vii, viii, ix (two species).

P. pentacystis, ROSA.
P. violacea, F. E. B.

It is clear from the above lists that two is the prevailing number of spermathecae in the genus *Perichaeta*. In all twenty-six species have but two pairs of spermathecae. The next commonest number is four; but there are only seventeen species which have four spermathecae as against sixteen which have three pairs. Eight species have only a single pair, and the rarest condition is to have five pairs; only two are in this condition. It will also be observed that where there are fewer than five pairs of spermathecae they occur in one or more of the segments occupied by those five. It seems, therefore, as if the fewer spermathecae could be derived from the larger number by a reduction; as, however, there is no species known in which the single pair of spermathecae are in segment v, it also appears as if the original number of spermathecae were rather four than five. And this suggestion coincides with the fact that the largest number of species whose spermathecae are constant to a given series of segments are those in which the spermathecae are in segments vi–ix. It is not however, possible, at least so far as we know at present, to classify the species of *Perichaeta*

in accordance with the number of spermathecae. The various groups defined with the help of this character do not agree in other particulars.

(9) The spermiducal glands vary greatly in size in the present genus; they are even, though very rarely, altogether absent; in *P. hilgendorfi* there seems to be not the least trace of them; and in *P. nipponica* they are reduced to the muscular duct into which opens, as usual, the sperm-duct. In other species they show a lesser or greater degree of lobulation and extend through more or fewer segments; in *P. taprobanae* the glands are so small that they are quite confined to one segment. The muscular duct of the spermiducal gland sometimes opens directly on to the exterior and sometimes indirectly through a dilated sac; the latter condition is to be found in *P. indica* and other species; I refer to it in connection with the genital papillae.

(10) The last character which is subject to variation in the genus is the number and position of the specially-thickened septa.

The following table gives the principal characters of the known species of *Perichaeta*. I have not included *P. everetti* and the few others which resemble it in being so near to *P. stelleri*.

In the following list and descriptions of the known species of *Perichaeta* (including a few described here for the first time) I have not followed any particular order or grouping. Of so many species our knowledge of important characters is wanting; and it appeared to me that no good would be gained by a systematic arrangement which could not be complete, and would probably be erroneous. On the other hand, it would not be of much use to group the species which are fairly thoroughly known as to all the characters made use of, since that would give the impression that the remaining species were not identifiable; and this impression would be quite wrong.

The genus *Perichaeta* is pre-eminently a tropical genus, and is especially abundant in the Old World, particularly in Asia and the East Indies. Of the seventy species enumerated in the following pages only *P. elongata*, *P. pallida*, *P. ringeana*, *P. bermudensis*, *P. barbadensis*, *P. hesperidum* are exclusively New World; a few species, viz. *P. indica*, *P. sumatrana*, *P. posthuma*, *P. houlleti*, *P. dyeri*, have been received from both quarters of the globe; and there are, of course, a few doubtful American forms enumerated in the list of unidentifiable species (on p. 397). Africa is so poorly off in species that only two have been thence described, viz. *P. capensis* and *P. dyeri*; and both these species occur also elsewhere.

Australia is as nearly barren of true *Perichaeta*; only three, *P. queenslandica*, *P. darnleiensis*, *P. peregrina*, have been described from that continent. *P. vitiensis*, *P. indica*, *P. upoluensis*, *P. grubei*, *P. novarae*, *P. hawayana* are inhabitants of the

	LENGTH.	SEGMENTS.	SETAE.	CLITELLUM.	GENITAL PAPILLAE.
P. fasciata	150 mm.	100	70 on segment viii	without setae	0
P. aeliana	100 mm.	120	74 on xi, xii, &c.	without setae	0
P. enganensis	170 mm.	140	80 on ix	without setae	0
P. grubei	90 mm.	120	60 on viii		four on xviii
P. novarae	90 mm.	102 (?)	48 on viii		0
P. urceolata	110 mm.		30–40	without setae	0
P. hawayana	100 mm.	95	40 on viii, 60 behind clitellum	xiv–xvi	six on xviii
P. philippina	240 mm.	125	44 on viii, 70 on xii		0
P. racemosa	110 mm.	100	46 on viii	xiv–xvi	0
P. pentacystis	110 mm.	82	100 on viii		six on xvii–xix
P. sieboldi	270 mm.	145	80 on viii	without setae	0
P. ijimae	110 mm.	112	60 on viii	without setae	0
P. tijibodae	50 mm.		44	without setae	0
P. sangirensis	140 mm.	113	44 in middle of body		0
P. ferdinandi	190 mm.	116	55 in middle of body	xiv–xvi	0
P. stelleri	190 mm.	153	56 in middle of body	xiv–xvi	six on xix–xxi
P. ringeana	70 mm.	107	34 on vii	xiii–xvi, without setae	0
P. neoguinensis	150 mm.	118	85 on viii 80 in xi, 65 on xix		0
P. pulchra	150 mm.	113	62 on xxi	?	0
P. hilgendorfi	150 mm.	120	60 on post-clitellar segments.	without setae	viii
P. bosschae	170 mm.	125		without setae	0
P. longa	370 mm.	132	60 on xx		0
P. udekemi	75 mm.	107	42 on viii		0
P. mandhorensis			56 on xi	xiv–xvi	0
P. pusilla	16 mm.	60	40–50	xiv–xvi, with setae on last segment	paired on xviii, xix, median on xx
P. carinensis	200 mm.	150	60 on viii		xviii
P. bournei	150 mm.	130	60		vi–viii, xviii
P. peguana	170 mm.	120	56 on viii, closer on ventral surface		xvii/xviii, xviii/xix
P. modiglianii	130 mm.	105	66, closer on ventral surface		xviii
P. acystis			ventral most enlarged	without setae	xix–xxiii
P. forbesi	225 mm.			xiv–xvi, with setae	xvii, xix–xxi
P. vaillanti				xiv–xvi, without setae	0
P. feae	360 mm.	160	100 on viii	xiii–xvii, with setae	0
P. birmanica	130 mm.	112	70		0
P. indica	101 mm.	111	40–54, ventral large anteriorly.	without setae	vi–viii
P. sumatrana			40–44		0
P. parva	25 mm.	85	40–44		0
P. hasselti	70 mm.	100	70–75, ventral closer		0
P. japonica	220 mm.		66		0
P. musica	570 mm.	166	100, small dorsal gap		0
P. annulata	195 mm.	130	65		0
P. vitiensis	75 mm.	70		xiv–xvi, without setae	0
P. violacea	60 mm.		44 on v, 50 on x, 40 on xvi	xiv–xvi, complete rows of setae	xviii/xix

SPERMATHECAE.	SPERMIDUCAL GLANDS.	DORSAL PORES.	OTHER PECULIARITIES.	LAST HEART.	LOCALITY.
viii, ix		xi/xii			Engano, &c.
vii, viii, ix		xii/xiii			,,
vi, vii, viii, ix		xii/xiii			,,
viii, ix	?	xi/xii			Tahiti.
viii, ix	?	xi/xii		?	,,
vi (and vii)	with terminal sac			?	Sumatra.
vi, vii, viii		x/xi		xiii	Hawai.
vii, viii, ix	with terminal sac	xi/xii		?	Cebu.
ix	with terminal sac	?		?	Borneo, Java.
v–ix		xiv/xv	gizzard in vii	xiii	Mahé.
vii, viii, ix		xii/xiii	six or seven caeca; egg-sacs in xiii	xiii	Japan.
vi, vii, viii		xvi/xvii	spermathecae without diverticulum	?	,,
viii, ix	with terminal sac			xiii	Java.
viii	with terminal sac	xi/xii	intestinal caeca in xv (?)	?	Sangir.
vii, viii	with terminal sac	xi/xii		xiv	,,
many in vi, vii		xii/xiii	calciferous glands in xiii; no caeca	xiii	,,
(vii), viii, ix		xi/xii		xv	Mexico.
vi, vii, viii, ix		xii/xiii	intestinal caeca absent	xiii	New Guinea.
viii	with terminal sac	xii/xiii		xiii	Luzon.
vii, viii	absent	xii/xiii	six or seven caeca	xiii	Japan.
vi–ix		xii/xiii			Borneo.
viii, ix		xiii/xiv		xiii	Sumatra.
vii, viii, ix	with terminal sac	viii/ix	spermathecae have a capsulogenous gland (?) appended	?	Java.
vi, vii, viii		x/xi		xiii	Borneo, Java.
vi					Buitenzorg.
vii–ix		xi/xii		xiii	Burmah.
vi–viii		xii/xiii		xiii	,,
vii–ix		xii/xiii		xiii	,,
vii–ix		xiv/xv		xiii	Nias.
absent (?)		?			Luzon.
viii, ix		xii/xiii	egg-sacs in xiv		New Guinea.
vi–ix	with terminal sac	?			Luzon.
vi–ix		xii/xiii		xiii	Tenasserim.
vi–viii		xii/xiii			Burmah.
vi–ix	without terminal sac	xii/xiii			Old and New World.
viii, ix					Old and New World.
viii, ix					
vi, vii					Sumatra.
vii, viii		xi/xii			Japan.
vii, viii					Java.
vii, viii					
viii	with terminal sac	xi/xii	one pair of testes		Viti.
v–ix		xi/xii		xii	Penang.

	LENGTH.	SEGMENTS.	SETAE.	CLITELLUM.	GENITAL PAPILLAE.
P. upoluensis	150 mm.			xiv–xv	ix, xvi–xx
P. posthuma	180 mm.	110	viii, 140; x, 108; xiii, 90	with setae	xvii, xix
P. aspergillum	370 mm.		80		group of pores on vii/viii, viii/ix, xviii
P. robusta	180 mm.		45		viii, ix, one pair on xviii
P. elongata	355 mm.				o
P. quadragenaria	210 mm.	100	40		o
P. pallida	125 mm.	95	59	xiv–xvi	xviii, xix, v/vi–vii/viii
P. martensi	155 mm.	125	36 on xiii		o
P. divergens	120 mm.	120	55		vii, viii, ix
P. capensis	130 mm.	110	60, 40 on vii	without setae	o
P. houlleti	200 mm.		52 behind clitellum	with peculiar setae	o
P. minima	25 mm.	80	44 near clitellum, 60 on vii	setae on xvi	vii, xvii–xix
P. dubia	140 mm.	120	40	without setae	o
P. inflata	55 mm.			without setae	o
P. nipponica	100 mm.	100		without setae	vii–ix
P. falcata	120 mm.		60	without setae	o
P. masatakae	125 mm.	90		without setae	viii, ix
P. tokioensis	58 mm.	67		without setae	xviii, viii–ix
P. dyeri	117 mm.	72	ii, 27; xiii, 39; xxvi, 45	xiv–xvi, without setae	two pairs on xviii
P. variabilis	160 mm.		54	without setae	o
P. sinensis	126 mm.	104	ii, 28; xiii, 42; xxvi, 48	xiv–xvi, without setae	xviii/xix
P. tenkatei	85 mm.	100	50	without setae	o
P. bermudensis	120 mm.	93		xiv–xvi, setae on xvi	group of pores on xvii
P. taprobanae	105 mm.	114	ii, 52; vi, 81; xiii, 74; xxvi, 67	with complete rows of setae	o
P. morrisi	52 mm.	93		xiv–xvi, setae on xvi	vii, viii
P. barbadensis	106 mm.	78		setae on one or more segments	vii, xviii
P. hesperidum				without setae	o
P. mauritiana	80 mm.	85		setae on xvi	xviii
P. queenslandica	150 mm.	120	60	with setae	ix–xi, xvii–xxii
P. darnleiensis	155 mm.	108	60-66	without setae	o
P. peregrina	130 mm.	108	40–66	with setae	o
P. vordermanni	315 mm.	175	80-90 on posterior segments	without setae	xvii. xix, vii, viii
P. sluiteri	190 mm.	135	60–70 on posterior segments; ventral setae longer and closer together	without setae	o
P. biserialis			ventralmost seta larger		o

SPERMATHECA.	SPERMIDUCAL GLANDS.	DORSAL PORES.	OTHER PECULIARITIES.	LAST HEART.	LOCALITY.
viii, ix		xii/xiii		xiii	Upolu.
vi–ix					Old and New World.
viii, ix				xiii	?
viii, ix			egg-sacs in xiii	xiii	Mauritius; Manilla.
v					Peru.
viii				xiv	East Indies.
vi, vii (viii)		?		xiii	Brazil.
vi, vii, viii, ix		xii/xiii	spermathecae peculiar	xiii	Banka.
vi, vii, viii, ix	glandular part absent	xii/xiii		xii	Japan.
(vii), viii, ix	very large, xv–xxiv	vi/vii–xii/xiii		xiii	Java; S. Africa.
vii–ix	large, xvi–xxii, with terminal sac	xi/xii	spermathecae with capsulogenous glands		Old and New World.
vii					Java.
vii–ix	with terminal sac	xii/xiii			Sumatra.
viii, ix	with terminal sac				Java.
vi–ix	glandular part absent		diverticulum of spermathecae with globular appendices	xiii	Japan.
viii, ix	with terminal sac				Flores.
viii, ix	glandular part absent		egg-sacs in xiii		Japan.
vii, viii			egg-sacs in xiii	xiii	,,
vi–ix	no terminal sac				West Indies, Lagos.
viii, ix					Soemba.
vi–ix	no terminal sac				Foochow.
viii, ix	with terminal sac	xi/xii	egg-sacs in xiii		Soemba.
vi–viii	no terminal sac	x/xi	egg-sacs in xiii, xiv		Bermudas.
viii	no terminal sac	xii/xiii	no caeca		Ceylon.
vi, vii	no terminal sac				Penang.
vi, vii (viii)	no terminal sac		egg-sacs in xiii, xiv		Barbadoes.
vii, viii	with terminal sac		egg-sacs in xiii		,,
vii, viii	no terminal sac		egg-sacs in xiii, xiv		Mauritius.
v–viii		xii/xiii	oviducal pores paired xii	xii	Australia.
vi–ix	with terminal sac	xi/xii	diverticulum of spermathecae with globular appendices	xiii	,,
vi–ix		xi/xii		xiii	Australia (?)
vi–ix		xiii/xiv		xiii	Billiton.
viii, ix		xi/xii		xiii	

Pacific islands. The remaining fifty (roughly) are confined to the oriental region, which is clearly the head-quarters of the genus.

In reviewing the structure of the different species there does not appear to be much correspondence to be traced between structure and distribution. The most marked instance of any such connection is to be seen in the Japanese species of the genus. There is a distinct tendency among the Japanese *Perichaeta* for the glandular part of the spermiducal glands to disappear. The occasional existence of six intestinal caeca in place of the usual *one* is another feature of the *Perichaeta* of this part of the world.

In addition to the species described in the following pages, there are a number of *Perichaeta*, which cannot be adequately defined, although it is fairly certain that they belong to the genus *Perichaeta* (s. s.). Many of them are probably synonymous with species which are well characterized under other names. Those *species inquirendac* are as follows:—

Megascolex diffringens, BAIRD, England.
Perichaeta juliani, PERRIER, Saigon.
Perichaeta bicincta, PERRIER, Philippines.
Amyntas aeruginosus, KINBERG, Guam.
Rhodopis javanica, KINBERG, Java.
Perichaeta subquadrangula, GRUBE, Viti.
Perichaeta rodericensis, GRUBE, Rodriguez.
Perichaeta tricystis, PERRIER, Brazil.
Perichaeta dicystis, PERRIER, Brazil.
Nitocris gracilis, KINBERG, Rio Janeiro.
Perichaeta viridis, SCHMARDA, Ceylon.
Megascolex sanctae-helenae, BAIRD, St. Helena.

None of these species are characterized sufficiently to enable their distinctness from those fully described here to be ascertained; but it seems to be the fact that they all belong to the genus *Perichaeta*. In several cases there are no positive data which render this conclusion absolutely certain. For instance, *P. dicystis* and *P. tricystis* have only been defined by the number of their spermathecae; it is their habitat which leads me to place both in the genus *Perichaeta*. So too, with regard to *Nitocris gracilis*. *P. viridis* I have examined myself and believe to be a true *Perichaeta*.

P. rodericensis is described as possessing a clitellum of only two segments, as has also *P. bicincta*. I have found myself that *P. upoluensis* is constantly in the same condition, but I am at present inclined to doubt whether this is a distinctive character. I fancy too that the location of the male pores of *P. rodericensis* on the seventeenth segment is not right; if it prove to be correct, then, of course, this species will at once become a 'good' one.

I am inclined to fancy that *Megascolex diffringens* is *P. indica;* the latter has been met with in hot houses in this country. At any rate, the woodcut of the worm given by BAIRD shows that it is a true *Perichaeta*.

P. juliani is stated to have continuous setae, a clitellum consisting of three segments commencing with the fourteenth, three to seven pairs of papillae after the male pores, and four pairs of spermathecae. This is not quite enough to distinguish the species.

Amyntas aeruginosus again is stated to have a clitellum with only two segments; it has two pairs of spermathecae.

Rhodopis javanica has a clitellum of the same extent, but the male pores are located between segments xv/xvi; without further evidence I cannot accept this as probable. The restricted clitellum is the principal reason for regarding this worm as in all probability a *Perichaeta*.

For the present we must also regard as *incertae sedis*, BOURNE'S *P. burlariensis*, which appears to be a true *Perichaeta*, though without intestinal caeca. *Megascolex sanctae-helenae* of BAIRD is practically unknown.

(1) Perichaeta bournei, ROSA.

P. Bournei, ROSA, Ann. Mus. Civ. Genova, vol. x (2a), 1890, p. 110.

Definition. *Length,* 150 *mm.; breadth,* 5 *mm.; number of segments,* 130. *Clitellum, XIV–XVI. Male pores on line of seta* 15*; inside of each two small papillae, one in front of the other. Setae,* 60 *per segment, closer ventrally. Dorsal pores commence XII/XIII. Caeca occupying segments XVII–XXV. Septa, IV/VIII, X/XIII thickened. Hearts in X–XIII. Spermathecae in VI–VIII; at aperture of each is a papilla; diverticulum as long as pouch, terminating in an oval dilatation. Sperm-sacs and sperm-reservoirs two pairs. Spermiducal glands with short duct. Hab.—Mount Carin* (1,300 *m.*), *Burmah.*

(2) Perichaeta peguana, ROSA.

P. Peguana, ROSA, loc. cit., p. 113.

Definition. *Length,* 170 *mm.; breadth,* 6 *mm.; number of segments,* 120. *Clitellum, XIV–XVI. Male pores on line with seta* 10*; on intersegmental grooves XVII/XVIII, XVIII/XIX, a pair of papillae a little to inside of male pores. Setae,* 56 *in anterior segments, closer ventrally. Dorsal pores commence XII/XIII. Gizzard in IX; intestine commences in middle of XIV, caeca in XXVI (XXIV). Septa IX/XI missing; septum XI/XII thickened. Hearts in X–XIII. Spermathecae in VII–IX, opening in line of seta* 12*; diverticulum consists of an oval sac in which lies a coiled-up tube. Sperm-reservoirs of each side communicate. Spermiducal glands occupy three segments, with short duct. Hab.—Rangoon.*

(3) Perichaeta vordermanni, HORST.

P. vordermanni, HORST, Notes, Leyd. Mus., vol. xii, 1890, p. 231.

Definition. *Length,* 315 *mm.; number of segments,* 175. *Clitellum, XIV–XVI, without setae. Male pores on a glandular area, extending over segments XVII–XIX, and bearing several papillae; on XVII and XIX a pair of papillae in line of setae, cor-*

responding in position to male pores; in front of posterior and behind anterior of these a sucker; on XVIII a pair of papillae to inside of male pores and in front of line of setae. Setae 80–90 *behind clitellum, fewer in front, diminishing forwards. Dorsal pores commence XIII/XIV. Septa V/VII, X/XII thickened. Hearts in X–XIII. Spermathecae in VI–IX; papillae on VII, VIII. Spermiducal gland, with horseshoe-shaped duct. Hab.—Billiton.*

(4) Perichaeta enganensis, Rosa.

P. enganensis, Rosa, Ann. Mus. Civ. Genova, vol. xii (2a), 1892, p. 546.

Definition. *Length,* 170 *mm.; breadth,* 7 *mm.; number of segments,* 140. *Clitellum, XIV–XVI, without setae. Male pores on line with seta,* 8, 3 *mm. apart. Setae,* 80 *on segment IX, closer ventrally. First dorsal pore, XII/XIII. Caeca in XXVI, reaching to XX. Septa VIII/X absent; none specially thickened. Spermathecae in VI–IX; diverticulum swollen at end, longer than pouch. Sperm-sacs in XI, XII; sperm-reservoirs in X, XI. Spermiducal gland with short duct. Hab.—Engano.*

Of this species Rosa describes a variety which he has called '*Tetra.*' The variety is much darker in colour than the type, being of an uniform black brown; the spermathecae also are different in that the pouch is quite distinct from its long duct.

(5) Perichaeta carinensis, Rosa.

P. carinensis, Rosa, Ann. Mus. Civ. Genova, vol. x (2a), 1890, p. 107.

Definition. *Length,* 200 *mm.; breadth,* 7 *mm.; number of segments,* 150. *Clitellum, XIV–XVI. Male pores on line with seta,* 15. *A pair of genital papillae on XVIII between male pores, but a little anterior to line of setae, while male pores are behind line of setae. Setae,* 60 *per segment in region of spermathecae. Dorsal pores commence XI/XII. Septa VIII/X absent; none are mentioned as specially thickened. Hearts in X–XIII. Spermathecae in VII–IX; diverticulum shorter than pouch. Sperm-sacs in XI, XII, the last pair much larger, extending through several segments. Spermiducal gland occupying three segments, with long duct. Hab.—Mount Carin* (1,100 *m.*), *Burmah.*

(6) Perichaeta feae, Rosa.

P. Feae, Rosa, Ann. Mus. Civ. Genova, vol. vi (2a), 1888, p. 161.

Definition. *Length,* 360 *mm.; breadth,* 8 *mm.; number of segments,* 160. *Clitellum, XIII–XVII, with setae. Male pores on line with fifteenth seta. Setae,* 100 *in spermathecal segments. Oesophagus with a circle of glands (calciferous glands?) in*

X; intestine with caeca in XXVIII, reaching to XXV. Septa V/VIII, IX/XII thickened. Spermathecae in VI–IX, with zigzag diverticulum. Sperm-sacs in XI, XII, latter very large; sperm-reservoirs in X, XI unpaired. Spermiducal gland with particularly long duct bent upon itself. Hab.—Kokareet (Tenasserim).

(7) Perichaeta birmanica, Rosa.

P. birmanica, Rosa, loc. cit., p. 164.

Definition. *Length,* 130 *mm.; breadth,* 6 *mm.; number of segments,* 112. *Clitellum, XIV–XVI. Male pores on line of seta,* 15. *Dorsal pores commence, XII/XIII. Setae,* 70 *to each segment. Septa, V/VII thickened. Spermathecae in VI–VIII, with diverticulum consisting of an oval sac containing a much-coiled tube. Sperm-sacs in XI, XII; sperm-reservoirs? Spermiducal glands occupy three segments; duct bent upon itself. Hab.—Rhamo (Irawaddi).*

(8) Perichaeta modiglianii, Rosa.

P. Modiglianii, Rosa, Ann. Mus. Civ. Genova, vol. vii (2a), 1889, p. 134.

Definition. *Length,* 130 *mm.; breadth,* 5 *mm.; number of segments,* 105. *Clitellum, XIV–XVI. Male pores on line with eighth seta; on inner side of each aperture a pair of minute papillae, one in front of the other. Setae,* 66 *in each segment, nearer together ventrally. First dorsal pore, XIV/XV. Gizzard attached by unusually long fibres reaching back to XIV; intestine begins in XVI. Hearts in XI–XIII. Spermathecae in VI–IX, with long zigzag diverticulum. Sperm-sacs in XI, XII; sperm-reservoirs in X–XI. Spermiducal glands occupying three segments, with bent duct. Hab.—Nias.*

(9) Perichaeta fasciata, Rosa.

P. fasciata, Rosa, Ann. Mus. Civ. Genova, vol. xii (2a), 1892, p. 543.

Definition. *Length,* 150 *mm.; breadth,* 6 *mm.; number of segments,* 100. *Clitellum, XIV–XVI, without setae. Male pores on line with eleventh seta. Setae,* 60–70 *in spermathecal region, closer ventrally. Dorsal pores commence XI/XII. Caeca in XXVI, reaching to XXII. Septa nowhere much thickened. Spermathecae in VIII, IX, with long and coiled diverticulum. Sperm-sacs in XI, XII; sperm-reservoirs in X, XI; the two last, like the two first, are distinct from each other, but there is a connection between the two of each side of the body. Spermiducal glands with a short straight duct. Hab.—Engano.*

(10) Perichaeta aeliana, Rosa.

P. aeliana, Rosa, Ann. Mus. Civ. Genova, vol. xii (2a), 1892, p. 545.

Definition. *Length,* 100 *mm.; breadth,* 6 *mm.; number of segments,* 120. *Clitellum, XIV–XVI, without setae. Male pores on line with seta,* 4. *Setae,* 74 *to a segment. Dorsal pores commence XII/XIII. Septa, none specially thickened. Caeca in XXVII–XXVIII. Spermatheca in VII–IX; diverticulum unusually long and coiled. Sperm-sacs on XI, XII; sperm-reservoirs in X, XI. Spermiducal glands with short straight duct. Hab.—Engano.*

(11) Perichaeta darnleiensis, Fletcher.

P. Darnleiensis, Fletcher, Proc. Linn. Soc. N. S. W., vol. i (2), 1886, p. 966.

Definition. *Length,* 108 *mm.; number of segments,* 155. *Clitellum, XIV–XVI, without setae. Male pores,* 3 *mm. apart, separated by twelve setae. No papillae. Setae,* 60–66 *per segment. Dorsal pores commence XI/XII. Caeca in XXVI, reaching to XXII. Septum IX–X missing; septa V/VIII, X/XIV thickened. Hearts in X–XIII. Spermathecae in VI–IX; diverticulum with globular diverticula, longer than spermathecae. Sperm-sacs in XI–XII; sperm-reservoirs in X, XI. Spermiducal glands in XVII–XIX; terminal sac present at opening of duct. Hab.—Darnley Island; Torres Straits.*

Of this species, as well as of *P. queenslandica* and *P. peregrina,* Fletcher has stated that the oviducal pores are paired. This requires verifying. I am inclined to believe this worm to be identical with *P. divergens.* The only difference seems to be the number of setae.

(12) Perichaeta peregrina, Fletcher.

P. peregrina, Fletcher, loc. cit., p. 969.

Definition. *Length,* 130 *mm.; breadth,* 5 *mm.; number of segments,* 108. *Clitellum, XIV–XVI, with setae. Male pores separated by fourteen setae. Setae,* 40–46 *per segment, most numerous posteriorly. Dorsal pores commence XI/XII. Intestine begins in XVI, caeca in XXVI (XXIII). Hearts in X–XIII. Septa VIII–X absent. Spermathecae in VI–IX; diverticulum as long as pouch. Sperm-sacs in XI, XII; sperm-reservoirs in X, XI. Spermiducal glands smooth with* U-*shaped duct. Hab.—Mauritius* (?).

Although this species was met with at Sydney it is believed to have been introduced from Mauritius, since it is met with only in conservatories and not in gardens.

The colour when alive is described as being 'above of a nearly uniform brown with a tinge of green, lighter below.'

(13) Perichaeta sluiteri, Horst.

P. sluiteri, Horst, Notes Leyd. Mus., vol. xii, 1890, p. 234.

Definition. *Length,* 190 *mm.; number of segments,* 135. *Clitellum without setae. Setae,* 60–75 *(in the caudal region); closer as well as longer ventrally. Dorsal pores commence XI/XII. Intestine begins in XV. Hearts in X–XIII. Septa V/VIII thickened. Spermathecae in VIII, IX; diverticulum bent like a 'Pan's pipe,' swollen at end. Spermiducal gland bilobed, duct longish and bent. Hab.—Billiton.*

(14) Perichaeta queenslandica, Fletcher.

P. Queenslandica, Fletcher, Proc. Linn. Soc., N. S. W., vol. i (2), 1886, p. 962.

Definition. *Length,* 150 *mm.; breadth,* 7 *mm.; number of segments,* 120. *Clitellum, XIV–XVI with setae. Male pores separated by fourteen setae,* 5 *mm. apart. Setae,* 60 *per segment. Genital papillae: on XVII, XIX, XX, XXI a pair of papillae in front of line of setae; between XVII/XVIII, XVIII/XIX other pairs; on IX–XI in front of line of setae. Dorsal pores commence XII/XIII. Gizzard in VII, VIII (?); caeca in XXV, reaching to XXI. Septum VII–VIII absent. Hearts in (?) XII. Spermathecae in VI–IX. One pair of testes and funnels in XI. Spermiducal glands in XVIII–XXI ducts short. Hab.—North Queensland.*

This species must, I imagine, be in some respects inaccurately described by Fletcher. At any rate it is desirable to have the anomalous position of the gizzard confirmed. That there is an inaccuracy here appears to be shown by his placing the origin of the intestinal caeca in xxv instead of in xxvi; however, the divergence is particularly mentioned in the text, so that Fletcher has, in all probability, verified carefully the difference. It is not clear in which segments the spermathecae lie. They are said to be in segments v–viii, but the apertures are described and figured as being between v/vi–vii/ix; it may be, of course, that they open posteriorly. The existence of a single pair of testes and sperm-duct funnels is remarkable, but it seems also to occur in *P. vitiensis.*

Fletcher has figured (**2**, Pl. xiii, fig. 6) the external characters of this species.

(15) Perichaeta violacea, new species.

Definition. *Length, about two inches. Colour during life a red violet upon the upper*

surface; clitellum yellow; these tints are largely preserved after alcohol. Clitellum, XIV–XVI, with complete rows of setae. Male pores correspond to sixth seta; only two setae on each side between the male pores. One pair of genital papillae just behind and to the outside of the male pores; on boundary-line of segments XVIII/XIX, continuous with the raised area on which the male pores are situated. The seta-formula:—I, 23; V, 44; X, 50; XVI, 40. Dorsal pores commence XI/XII. Intestine begins in XV. Septa V/VIII and IX/XI thickened. Last pair of hearts in XII. Five pairs of spermathecae in V–IX; each has a single narrow diverticulum about half as long as the pouch, and swollen at its extremity. The apertures which are not all accurately in line, correspond to the sixth seta, and thus also correspond to the male pores. The median oviducal pore (on XIV) is continued on to front end of the segment by a groove. Sperm-sacs in XI, XII; sperm-reservoirs in X. Spermiducal glands occupy segments XVI–XX; duct bent upon itself; the distal half of this tube is thick-walled and spindle-shaped; the sperm-duct joins the commencement of the thin-walled portion. Hab.—Penang.

The setae upon first two segments of clitellum are small, but large upon the last segment. On segment x the setae are also markedly smaller than on other segments.

(16) Perichaeta pulchra, Michaelsen.

P. pulchra, Michaelsen, Arch. f. Nat., 1892, p. 233.

Definition. *Length, 150 mm.; breadth, 6 mm.; number of segments, 113. Male pores separated by sixteen setae; their position corresponds to about eleventh seta. Setae more densely arrayed on ventral side; on XXI, 62. Dorsal pores commence XII/XIII. Caeca with five or six indentations on lower margin. Septa IV/VII, X/XIII thickened. Hearts in X–XIII. Spermathecae one pair in VIII, with single diverticulum not so long as pouch. Sperm-sacs in XI, XII communicating with two pairs of sperm-reservoirs in X, XI. Spermiducal glands compact, with extremely short wide duct. Hab.—Luzon.*

This species is also marked by its colouration; I have not, as I have in several cases, included a description of this in the definition. The reason for this omission is that the colour is only known in the preserved worm. Each segment is traversed by a white ring which occupies the line of insertion of the setae; the intersegmental zones are purple; on the ventral side the white zones increase in width so as to ultimately occupy the whole of each segment. On the dorsal side the converse takes place; the white lines get narrower and narrower until they are reduced to a series of white spots, whence arise the setae.

(17) **Perichaeta hilgendorfi,** MICHAELSEN.

P. Hilgendorfi, MICHAELSEN, Arch. f. Nat., 1892, p. 235.

P. rokugo, BEDDARD, Zool. Jahrb. vi, 1893, Abt. f. Syst., p. 756.

Definition. *Length,* 150 *mm.; breadth,* 6 *mm.; number of segments,* 120. *Clitellum XIV–XVI. Male-pores invisible externally. A mass of pores lies on the VIIIth segment in the middle line in front of the setae and in one specimen a similar area lay upon the IXth segment; these areas correspond to masses of stalked glands which open by the pore. Setae more than* 60 *in segments behind clitellum. Dorsal pores commence XII/XIII. Gizzard in VIII, IX; intestine furnished with caeca* 6–8 *in number on each side lying in XXVI; it begins in segment XV. Septa IV/VII, X/XIII thickened. Hearts in X–XIII. Spermathecae in VII, VIII sometimes in VI also, with diverticulum longer than pouch. Sperm-sacs. Spermiducal glands absent, sperm-ducts open on segment XX* (*about*). *Hab.—Japan.*

There is no doubt that this species is identical with that described by myself as *P. rokugo.* A comparison of my description with that given by MICHAELSEN shows no points of disagreement. The chief character of the species is of course the total absence of the spermiducal glands, which have now been found absent in eight examples. MICHAELSEN'S statements as to the segment upon which the sperm-ducts open are no more precise than my own. The spermatheca is figured by MICHAELSEN; the external characters, the spermatheca, the 'capsulogenous glands,' the intestinal caeca, the sperm-sac by myself.

(18) **Perichaeta longa,** MICHAELSEN.

P. longa, MICHAELSEN, Arch. f. Nat., 1892, p. 239.

Definition. *Length,* 370 *mm.; breadth,* 10 *mm.; number of segments,* 132. *Clitellum XIV–XVI. Male pores separated by* 16 *setae. Setae* 60 *in number on segment XX. Dorsal pores commence XIII/XIV. Intestine begins in XV; caeca long extending from segment XXVI–XXIII. Septa IV/VII, XI/XIV thickened. Hearts in XI–XIII. Spermathecae in VIII, IX, with long coiled diverticulum reaching into segment in front. Sperm-sacs in XII; two pairs of sperm-reservoirs in X, XI. Spermiducal glands occupying segments XVII–XIX, with long ʃ-shaped duct. Hab.—Kepiahang* (*Sumatra*).

This species comes near to *P. musica.* It appears to differ from it mainly in its smaller size and in the absence of pigment, and also in the fewer setae. MICHAELSEN thinks that the circular male pores of *P. longa* are to be distinguished from the 'slit-shaped' pores of *P. musica.*

(19) **Perichaeta sinensis,** BEDDARD.

P. sinensis, BEDDARD, P. Z. S., 1892, p. 158.

P. monilicystis, MICHAELSEN, Arch. f. Nat., 1892, p. 251.

Definition. *Length,* 126 *mm.; breadth,* 3.5 *mm.; number of segments,* 104. *Colour pale brown posteriorly, darker in front. Clitellum XIV–XVI without setae. Male pores separated by six setae; behind and to the inside of each pore a papilla lying on boundary line of XVIII, XIX; a grape-like mass of white glands corresponds to each papilla. The seta formula is:—I,* 28; *V,* 26; *XII,* 42; *XXV,* 48; *setae of segments VI–IX longer and stouter than those upon anterior and posterior segments; this is especially the case with those more laterally placed. Spermathecae four pairs in VI–IX; diverticulum as long as pouch, but there is some variation; the diverticulum has frequently a beaded appearance due to the existence of constrictions at regular intervals. Spermiducal gland has no terminal sac connected with the muscular duct. Hab.—Foochow, China (also found by MICHAELSEN in a forcing house in Botanical Gardens of Berlin).*

I have figured the living worm, the genital papillae and clitellum, the spermatheca with its contents, and the vascular network upon it (Pl. ix, figs. 3 and 5; Pl. x, figs. 2, 3, 4, 7, 8).

(20) **Perichaeta bermudensis,** BEDDARD.

P. bermudensis, BEDDARD, P. Z. S., 1892, p. 160.

Definition. *Length,* 120 *mm.; breadth,* 4 *mm.; number of segments* 93. *Colour reddish brown dorsally, passing into a yellowish ventrally. Clitellum XIV–XVI; setae (about* 20) *on XVI. Male pores close to the ventral median line; behind each pore is a group of about five papillae. Setae small on the first setigerous segment; they gradually increase in size on the next three and then get small again; they are quite small on segment IX. Dorsal pores commence X/XI. In segments V and VI are blood-glands. Spermathecae two pairs in VI, VII, VIII; each has a single diverticulum about half as long as the pouch. In segments XIII and XIV are the egg-sacs. The sperm-sacs are in XI, XII. Spermiducal gland has no terminal dilatation. Hab.—Bermudas.*

I formerly (**45**) confounded this species with *P. aspergillum;* it is, however, evidently distinct. The principal difference is the fact that in *P. aspergillum* all the segments of the clitellum are furnished with setae, and that there are papillae in the neighbourhood of the spermathecae as well as the spermiducal glands; and it is furthermore a considerably smaller species.

(21) Perichaeta dyeri, Beddard.

P. dyeri, Beddard, loc. cit., p. 157.

Definition. *Length,* 117 *mm.; breadth,* 4 *mm.; number of segments* 72. *Colour during life a rich dark brown, darker posteriorly. Clitellum XIV–XVI, without setae. Male pores are separated by fifteen setae. Two pairs of genital papillae; one pair in front and a little to inside of male pore; the other occupies a similar position behind the male pore. The seta formula is:—I,* 27*; V,* 27*; XII,* 39*; XXV,* 45. *Caeca arise in XXVI, at the posterior margin of this segment and extend to the XXVth segment. From segment XXVIII are a series of septal glands. Last pair of hearts in XIII. Spermathecae four pairs in VI–IX; diverticulum half again as long as pouch. Sperm-sacs in XI, XII. Spermiducal glands extending through segments XVI–XXI; muscular duct without terminal sac. Hab.—Trinidad; Jamaica; Lagos, West Africa.*

I have examined a large number of examples of this species. This examination has shown that the characters of the papillae are not always absolutely distinctive of the species; in a good number only one pair (the posterior pair) were present. The species is remarkable for its wide range, but there are other examples in this genus and in other genera. I have elsewhere remarked upon species which are common to Lagos and to the West Indies.

(22) Perichaeta taprobanae, Beddard.

P. taprobanae, Beddard, loc. cit., p. 163.

Definition. *Length,* 100 *mm.; breadth,* 6.5 *mm.; number of segments,* 114. *Clitellum XIV–XVI, with complete rows of setae. Male pores separated by seventeen setae. The seta form is:—II,* 52*; VI,* 81*; XIII,* 74*; XXVI,* 67*; larger posteriorly. Dorsal pores commence XII/XIII. Caeca absent. Septa V/VII, X/XII thickened. Spermathecae in VIII. Spermiducal glands small, limited to segment XVIII; no terminal sac. Hab.—Ceylon.*

(23) Perichaeta morrisi, Beddard.

P. morrisi, Beddard, loc. cit., p. 166.

Definition. *Length,* 52 *mm.; number of segments,* 93. *Clitellum XIV–XVI; setae on last segment of clitellum. Male pores not wide apart; minute glands open in neighbourhood. Spermathecae in VI, VII; on segments VII, VIII a single median papilla in front of line of setae. Spermiducal glands without terminal sac. Hab.—Penang.*

I have given a coloured sketch of this species.

(24) Perichaeta barbadensis, BEDDARD.

P. barbadensis, BEDDARD, loc. cit., p. 167.

Definition. *Length,* 105 *mm.; breadth,* 4 *mm.; number of segments,* 78. *Clitellum XIV–XVI, with setae on some of the segments. Male pores quite lateral in position, separated by diameter of body. Genital papillae variable in number; some in neighbourhood of male pores, and occasionally one in neighbourhood of spermathecal pores. Setae. Egg-sacs in XIII, XIV. Spermathecae in VI, VII, and (sometimes) VIII. Spermiducal glands extensive, reaching from segments XVII–XXI; no terminal sac. Hab.—Barbadoes.*

In my description of this species three individuals were described. All of these differed in some particular from each other; hence it is a matter of guess-work to abstract the specific characters. The variations affect the setae upon the clitellum, the genital papillae and the number of the spermathecae. The following are the characters of the three individuals:—

1. About six setae upon the last segment of the clitellum[1]. A median papilla upon segment vii, just in front of setae, and another papilla occupying a corresponding position on segment xviii. Spermathecae in vi, vii.
2. Setae (about nine in number) on last segment of clitellum. On segment xviii two papillae on each side to inner side of atrial pore. Three pairs of spermathecae in vi–viii.
3. Setae on last segment of clitellum about as numerous as in 2; also setae three or four in number on segment xiv. Papillae complicated; on xviii 'a small circular papilla lies above each atrial pore and another lies exactly below it, on the boundary line between segments xviii/xix. In the middle of segment xviii are two papillae lying side by side and above the setae of that segment. On the right-hand side of the body is another papilla, which lies just above one of these two. There are thus seven papillae in all.' Spermathecae in vi, vii.

These differences cannot be accounted for by differences in age. It is true that, as in *Typhoeus orientalis* for example, the genital papillae do differ in individuals, the difference being very possibly one of maturity; but in the present instance there is no sort of correspondence between the variations in the genital papillae and in the variations of the clitellar setae. In immature worms, which have no setae upon the clitellum, when fully mature the segments that will be subsequently modified into the clitellum have their full complement of setae; it might therefore be suggested

[1] More are (erroneously) represented in my illustration (loc. cit. Pl. ix, fig. 6).

that the individual with more setae upon the clitellum was less mature than the one with fewer setae; but if there were so there is no agreement with the number of genital papillae. The individual with the most complicated arrangement of papillae has not so many setae upon the clitellum as an individual with fewer papillae. It might be urged that the differences here enumerated are of specific value. This may be so; but in the meantime there are not sufficient specimens known to enable us to decide the point.

(25) Perichaeta tokioensis, BEDDARD.

P. tokioensis, BEDDARD, Zool. Jahrb. Bd. vi, 1893, Abt. f. Syst., p. 762.

Definition. *Length*, 62 *mm.; breadth*, 6 *mm.; number of segments*, 67. *Clitellum XIV–XVI, without setae. Male pores conspicuous; near to them, and to the inside are two or three small apertures with corresponding glands. Male pores* 5 *mm. apart Intestine begins in XV. No specially thickened septa. Hearts in X–XIII. Spermathecae in VII, VIII; on VIII, IX are a pair of papillae to the inside of spermathecal pores. Sperm-sacs in XI, XII, not very large. Spermiducal glands well developed extending through segments XVII–XX; very lobulatc. Hab.—Japan.*

This species is remarkable among the Japanese Perichaetidae in that it has well-developed spermiducal glands; the only other species which agrees with it in this are *P. sieboldi*, *P. japponica*, and *P. schmardae*. The stalked glands in connexion with the anterior set of papillae seem to vary somewhat in arrangement. I infer this, although I have only had a single specimen to examine, from the fact of their asymmetrical arrangement in this specimen. This is the way in which they were disposed. On the left side of the body two or three glands open on to the papilla of the eighth segment; on the next segment one gland opens on to the papilla and another on to the stalk of the spermatheca. On the right side of the body a single gland corresponds to each papilla, and another pair unite to open close to if not in common with the spermathecae of segment viii.

This species may be the same as HORST'S *P. schmardae*. I retain my own name, however, as this identification is not certain. The brief notes given by MICHAELSEN (**10**, p. 27) upon the same species are not against this identification.

(26) Perichaeta nipponica, BEDDARD.

P. nipponica, BEDDARD, loc. cit., p. 760.

Definition. *Length*, 100 *mm.; breadth*, 4 *mm.; number of segments*, 100. *Clitellum XIV–XVI, without setae. Male pores separated by fourteen setae. Intestine begins in XVI.*

Hearts in X–XIII. No egg-sacs (?). Spermathecae in VI–IX; each has a diverticulum longer than pouch; to these are appended a variable number of small globular sacs; near to orifices of spermathecae on segments VII–IX (in front of line of setae) are a pair of papillae which correspond to whitish glands seen inside the body. Septa separating X/XV thickened. Sperm-sacs in XI, XII. Spermiducal glands consist merely of the muscular duct. Hab.—Japan.

The main peculiarity of this species is in the form of the spermathecae, which is only paralleled in the case of *P. martensi*.

(27) Perichaeta masatakae, Beddard.

P. masatakae, Beddard, loc. cit., p. 761.

Definition. *Length,* 125 *mm.; breadth,* 6 *mm.; number of segments,* 90. *Clitellum, XIV–XVI, without setae. Intestine begins in XV. Septa XXV are thickened. Spermathecae in VIII, IX small with a diverticulum longer than pouch. On VIII, IX are paired papillae, to each papilla corresponds a pair of white glands. Egg-sacs in XIII. Spermiducal glands represented by muscular duct alone. Sperm-sacs in XI, XII. Hab.—Japan.*

This species, like *P. divergens* and the majority of the Japanese Perichaetidae, has no glandular appendix to the atria. The number of spermathecae distinguishes this species from *P. divergens.*

(28) Perichaeta ijimae, Rosa.

P. Ijimae, Rosa, Ann. k. Hofm. Wien, Bd. vi, 1891, p. 402.

Definition. *Length,* 110 *mm.; breadth,* 7 *mm.; number of segments,* 112. *Clitellum, XIV–XVI, without setae. Male pores on large broad papillae. Setae* 60 *on segments VI–VIII. Dorsal pores commence XVI/XVII. Intestine begins in XV, with long caeca extending through five segments, arising in XXV. Septa IV/VIII, XIII/XIV thickened. Spermathecae in VI–VIII opening in line with seta* 9*; no diverticulum. No egg-sacs. Sperm-sacs in XI, XII; sperm-reservoirs unusually large in X, XI. Spermiducal glands extend through XV–XX, with short straight duct. Hab.—Japan.*

This species is chiefly remarkable for the absence of diverticula to the spermathecae.

(29) Perichaeta minima, Horst.

P. minima, Horst, Zool. Ergebn. Ost-Indien, Bd. ii, p. 66.

Definition. *Length,* 25 *mm.; number of segments,* 80. *Clitellum, XIV–XVI (?); on XVI*

five setae on each side. Male pores on a depressed area extending over segments XVII–XIX. A pair of papillae on VII anterior and near anterior border. Setae 44 in segments bordering clitellum; on VII, 60. Spermathecae in VII opening on to papilla, diverticulum two-thirds as long as pouch swollen at extremity. Spermiducal glands with ʃ-shaped duct without terminal sac. Hab.—Java.

This species is chiefly remarkable for its small size; it is the smallest species known with the exception of *P. violacea*, from which however it is easily distinguishable. It appears to be unpigmented.

(30) Perichaeta hesperidum, Beddard.

P. hesperidum, Beddard, P. Z. S., 1892, p. 169.

Definition. *Length, 105 mm.; breadth, 4 mm.; number of segments, 78. Clitellum, XIV–XVI, without setae. Male pores quite lateral in position, separated by diameter of body. Caeca remarkably small; typhlosole well marked; large intestine begins in XV. One pair of egg-sacs in XIII. Spermathecae in VII, VIII. Spermiducal gland with very minute terminal sac. Hab.—Barbadoes.*

This species is, in its general appearance, very like *P. barbadensis*. The characters, however, as described by me are sufficient to distinguish the species. It is, however, possible that we have to deal here with a single species of protean form, the present 'species' representing one extreme.

(31) Perichaeta mauritiana, Beddard.

P. mauritiana, Beddard, loc. cit., p. 170.

Definition. *Length, 80 mm.; number of segments, 85. Clitellum, XIV–XVI, the last segment with a few setae. Male pores with three small papillae to inner side. Spermathecae in VII, VIII; diverticulum longer than pouch, with globular extremity. Two pairs of egg-sacs in XIII, XIV. Spermiducal glands extensive, reaching from XVII–XXII, without terminal sac. Hab.—Mauritius.*

(32) Perichaeta pallida, Michaelsen.

P. pallida, Michaelsen, Arch. f. Nat., 1892, p. 227.

Definition. *Length, 125 mm.; breadth, 5 mm.; number of segments, 95. Clitellum, XIV–XVI. Male pores wide apart, 2–4 papillae round each pore; besides these there are a pair of papillae on XIX and two pairs on VII; in some specimens two or three papillae on intersegmental furrows V/VI and VI/VII or VII/VIII. Intestine begins in XIII; caeca present*

arising in XXVI. Hearts in segments XI–XIII. Two (or three) pairs of spermathecae in VI, VII (VIII); diverticulum swollen at extremity. Sperm-sacs in XI, XII communicating with paired sperm-reservoirs in X, XI. Spermiducal glands large, extending through segments XVI–XXII; duct not much bent. Hab.—Porto Alegre, Brazil.

The setae in this species are stated by MICHAELSEN to be as many as fifty-nine in the middle segments of the body. The presence of dorsal pores was not ascertained. There seems to be no pigment in the skin. In the anterior region of the body there is a slight dorsal interval between the setae.

(33) Perichaeta neoguinensis, MICHAELSEN.

P. neoguinensis, MICHAELSEN, loc. cit., p. 229.

Definition. *Length,* 150 *mm.; breadth,* 8 *mm.; number of segments,* 94. *Clitellum, XIV–XVI. Male pores close to ventral middle line, separated by nine setae. Setae: VIII,* 85; *XI,* 80; *XIX,* 65. *Dorsal pores commence XII/XIII. Gizzard in IX, X; intestine (without caeca) begins in XV. Septa V/VIII, X/XII thickened. Hearts in XI–XIII. Spermathecae on VI–IX, opening close together; diverticulum very short. Sperm-sacs in XII, with a sperm-reservoir attached to each. Spermiducal glands limited to eighteenth segment with but slightly bent duct. Hab.—New Guinea.*

In the absence of caeca and in the small spermiducal glands the present species agrees with *P. taprobanae;* but that species has only a single pair of spermathecae.

(34) Perichaeta martensi, MICHAELSEN.

P. Martensi, MICHAELSEN, loc. cit., p. 242.

Definition. *Length,* 155 *mm.; breadth,* 4 *mm.; number of segments,* 125. *Clitellum, XIV–XVI. Male pores separated by nine setae. Setae occasionally show a faint interruption in dorsal median line; on XII,* 36. *Dorsal pores commence XII/XIII. Caeca short, reaching only to twenty-fifth segment. Hearts in XI–XIII. Spermathecae in VI–IX, with a duct as long as pouch; on the top of this duct a diverticulum which gives off an accessory spherical diverticulum; the junction of pouch and duct is beset with numerous filamentous processes. Spermiducal glands with a long and slender duct. Hab.—Banka.*

This species is to be defined by its peculiar spermatheca, the structure of which is not entirely cleared up by MICHAELSEN. There seems to be no pigment in the skin, as the worm is described as of a yellow colour. Is this species really different from *P. darnleiensis?* See description of latter.

(35) Perichaeta divergens, MICHAELSEN.

P. divergens, MICHAELSEN, loc. cit., p. 243.

Definition. *Length,* 120 *mm.; breadth,* 6 *mm.; number of segments,* 120. *Clitellum, XIV–XVI. Setae,* 55 *in each segment. Dorsal pores commence in XII/XIII. Intestine with simple diverticula. Hearts in X–XII. Spermathecae in VI–IX, with cylindrical diverticulum as long as the pouch; on segments VI/VII–VIII/IX three pairs of papillae. The spermathecal pores get further and further away from the median line from before backwards. Sperm-sacs in XI, XII; sperm-reservoirs in X, XI. Sperm-sacs consist of two parts, a larger lower portion and a smaller dark-coloured part ranging into the body-cavity. Spermiducal glands absent. Hab.—Japan.*

The resemblance of this species to *P. masatakae* is dealt with under the description of the latter.

(36) Perichaeta grubei, ROSA.

P. Grubei, ROSA, Ann. k. Hofm. Wien, Bd. vi, 1891, p. 395.

P. taitensis, GRUBE, Anneliden der Novara, pp. 35, 37 (in part.).

Definition. *Length,* 90 *mm.; breadth,* 5 *mm.; number of segments,* 120. *Clitellum XIV–XVI. Male pores on eighth seta row; between them, behind row of setae, are four papillae. Setae,* 60 *on segment VIII. Dorsal pores commence XI/XII. Spermathecal pores VII/VIII, VIII/IX, on line with eighth seta. Hab.—Tahiti.*

(37) Perichaeta novarae, ROSA.

P. Novarae, ROSA, Ann. k. Hofm. Wien, Bd. vi, 1891, p. 396.

P. taitensis, GRUBE, Anneliden der Novara, pp. 36, 37 (in part.).

Definition. *Length,* 90 *mm.; breadth,* 5 *mm.; number of segments, more than* 102. *Clitellum XIV–XVI. Male pores on eighth seta line. Spermathecal pores on VII/VIII, wide apart. Setae, about* 48 *on segment VII. Dorsal pores commence XI/XII. Hab.—Tahiti.*

The species named by GRUBE *P. taitensis* has been recently examined by ROSA, who finds that two distinct species were included under this name. As the point has been definitely settled by ROSA, it is a waste of time and space to refer back to GRUBE'S description. It will be obvious from the above descriptions that ROSA is quite justified in separating the two forms. I would remark, however, that ROSA'S description does not entirely fit his figures. He says that the two spermathecal pores

of *P. grubei* are in line with the eighth seta. This statement refers, so far as the figures are concerned, not to that species but to *P. novarae;* the pores of the former are much more closely approximated than those of the latter, a fact which is, of course, duly noted by ROSA.

(38) Perichaeta sangirensis, MICHAELSEN.

P. sangirensis, MICHAELSEN, JB. Hamb. wiss. Anst., Bd. viii, 1890, p. 36.

Definition. *Length,* 140 *mm.; breadth,* $4\frac{1}{2}$ *mm.; number of segments,* 113. *Clitellum, XIV–XVI. Male pores separated by about a sixth of the total circumference. Setae,* 44 *in number to each segment in middle of body. Faint gaps. Dorsal pores commence XI/XII. Intestine begins in XIV, with a pair of caeca in XV (?). Spermathecae in VIII, with a slender diverticulum expanded at end. Sperm-saes in XI, XII communicating with reservoirs in X, XI. Spermiducal glands extending through segments XVII–XIX; duct opening into a terminal sac. Hab.—Sangir.*

(39) Perichaeta ferdinandi, MICHAELSEN.

P. ferdinandi, MICHAELSEN, loc. cit., p. 38.

Definition. *Length,* 190 *mm.; breadth,* $6\frac{1}{2}$ *mm.; number of segments,* 116. *Clitellum, XIV–XVI. Male pores separated by about one-sixth of circumference of body. Setae with faint dorsal gaps,* 55 *in middle segments, fewer in front and behind and at the same time larger. Dorsal pores commence XI/XII. Gizzard in VI–VIII (?); intestine begins in XIV, with caeca in XXVII (?). Septa X/XIV thickened. Hearts in XII–XIV. Spermathecae in VII, VIII, each with a diverticulum (or two) shorter than pouch. Sperm-sacs in X (?), XI, XII, with sperm-reservoirs in X, XI. Spermiducal glands large extending through XVII–XIX; duct arched with terminal sac. Hab.—Sangir.*

MICHAELSEN is not certain whether in dissecting the worm he may not have accidentally removed one of the two diverticula in those cases where there appeared to be only one. The spermathecae lie sometimes in front of, sometimes behind, the pores on vi/vii, vii/viii. The ground colour of the preserved specimens is a clear brown, the seta lines being white; on the dorsal surface the colour is purple.

(40) Perichaeta mandhorensis, MICHAELSEN.

P. mandhorensis, MICHAELSEN, Arch. f. Nat., 1892, p. 241.

Definition. *Clitellum, XIV–XVI. Male pores widely separated. Setae with faintly marked dorsal and ventral gaps;* 56 *on segment XI. Dorsal pores commence X/XI. Intestine*

begins in XV; caeca are indented on lower border forming two processes. Hearts in XI–XIII. Spermathecae in VI–VIII; duct of pouch as long as itself, the diverticulum more than half as long as spermathecae, terminating in a knobbed end. Sperm-sacs and sperm-reservoirs two pairs; former in XI, XII; latter in X, XI. Spermiducal glands open by a duct, which is slightly bent into an ʃ-shape. Hab.—Borneo; Mandhor, Java.

No measurements can be given as MICHAELSEN had only one specimen, incomplete. This being the case, it is remarkable that he gives the list of localities which I copy here.

(41) Perichaeta stelleri, MICHAELSEN.

P. stelleri, MICHAELSEN, JB. Hamb. wiss. Anst., Bd. viii, 1890, p. 39.

Definition. *Length,* 190 *mm.; breadth,* 7 *mm.; number of segments,* 153. *Clitellum,* $\overline{XIV}$*–XVI; without setae. Male pores separated by fourteen setae. On segments XIX–XXI are a pair of papillae, which get nearer together posteriorly; the last pair being separated by nine setae. Setae with faintly marked gaps; fifty-six in segments of middle of body. Dorsal pores commence XII/XIII. Calciferous glands in XIII. Intestine begins in XIV; no caeca. Septa V/VIII, XI/XIV thickened. Hearts in X–XIII. Spermathecae* 16–28 *in number in segments VI, VII, with diverticula. Sperm-reservoirs in X, XI, connected with an equal number of sperm-sacs. Spermiducal glands occupy XVII–XIX, with horseshoe-shaped duct. Hab.—Sangir.*

This species is like *P. everetti* and a few other allies for the fact that it possesses, like certain Geoscolicidae, numerous spermathecae in one segment. Each of the spermathecae has a diverticulum, which is swollen where it arises from pouch; then becomes a slender thread, and finally expands again at the free extremity. The diverticula are about one quarter the length of the pouches; it is not quite certain whether some of the pouches may not have more than one diverticulum.

(42) Perichaeta ringeana, MICHAELSEN.

P. ringeana, MICHAELSEN, JB. Hamb. wiss. Anst., Bd. vii, 1889, p. 10.

Definition. *Length,* 70 *mm.; breadth,* $3\frac{1}{2}$ *mm.; number of segments,* 107. *Clitellum,* $\overline{XIII}$*–XVI, without setae. Male pores on level with ninth seta, situated on papillae which extend over segments XVII–XIX. Setae: on VII,* 34*; on III,* 24*;* 56 *in middle segments. Dorsal pores commence XI/XII. Oesophagus much folded in XII, XIII; intestine with a diverticulum reaching through several segments, with typhlosole. Hearts in XI–XV. Spermathecae in VIII, IX, with a long diverticulum expanded at end.*

Sperm-sacs in XI, XII; sperm-reservoirs in X, XI. Spermiducal glands well developed. Hab.—Vera Cruz (Mexico).

In one specimen MICHAELSEN found an additional pair of spermathecae in vii. The dorsal surface of the preserved worms is brownish with a median purple stripe.

(43) Perichaeta hawayana, ROSA.

P. Hawayana, ROSA, Ann. k. Hofm. Wien, Bd. vi, 1891, p. 396.

Definition. *Length,* 100 *mm.; breadth,* 4 *mm.; number of segments,* 88–95. *Clitellum, XIV–XVI. Male pores on ninth seta; close to pore on each side a group of three papillae. Intestine begins in XV; the two caeca have a pinnate appearance. Septa V/VIII, X/XII are thickened; septa VIII/IX, IX/X are wanting. Hearts in segments X–XII. Three pairs of spermathecae in VI, VII, VIII; diverticulum as long as pouch, with a dilated extremity. Sperm-sacs in XI, XII; they communicate with the sperm-reservoirs of segments X, XI. Spermiducal glands large, extending through seven segments (XVII–XXIII), no terminal dilatation to the muscular duct. Hab.—Hawai.*

(44) Perichaeta racemosa, ROSA.

P. racemosa, ROSA, loc. cit., p. 399.

Definition. *Length,* 110 *mm.; breadth,* 5 *mm.; number of segments,* 100. *Clitellum, XIV–XVI. Male pores in line with seventh seta. Setae* 46 *in segment VIII. Dorsal pores absent (?). Gizzard in IX (?). Septa V/VII thickened. Spermathecae in IX, diverticulum divided at free end into* 3–5 *globular sacs. Sperm-sacs in XI, XII. Spermiducal glands small, with straight short duct opening into a terminal sac. Hab.—Borneo; Java.*

(45) Perichaeta sieboldi (HORST).

Megascolex Sieboldi, HORST, Notes Leyd. Mus., vol. v, 1883, p. 191.
P. Sieboldii, ROSA, Ann. k. Hofm. Wien, Bd. vi, 1891, p. 401.

Definition. *Length,* 270 *mm.; breadth,* 10 *mm.; number of segments,* 135. *Clitellum, XIV–XVI, without setae. Male pores on line with seta fourteen. Setae,* 76–80 *on spermathecal segments. Dorsal pores commence XII/XIII. Intestine begins in XV, caeca with six or seven diverticula. Septa in front of segment VIII thickened; also X/XIV. Hearts in X–XIII. Spermathecae in VII–IX opening on line with seta eighteen; diverticulum zigzag shaped. Sperm-sacs in XI, XII; sperm-reservoirs in X, XI. Egg-sacs in XIII. Spermiducal glands with short straight duct. Hab.—Japan.*

It is not quite certain whether the species described by myself (**30**) under this name is the same as that called *P. sieboldi* by HORST. My specimen was only 112 mm. in length, and was built of only 74 segments; as size is so often an index of specific distinctness, it is possible that this individual is really distinct.

(46) Perichaeta philippina, ROSA.

P. philippina, ROSA, Ann. k. Hofm. Wien, Bd. vi, 1891, p. 397.

Definition. *Length,* 240 *mm.; breadth,* 7 *mm.; number of segments,* 125. *Clitellum, XIV–XVI. Male pores on line with seventh or eighth seta. Setae:—on VIII,* 44; *on XII,* 70. *Dorsal pores commence XI/XII. Hearts in X–XIII. Spermathecae in VII–IX, with a single diverticulum expanded at end. Sperm-reservoirs in X, XI; sperm-sacs large with a narrow, long extremity. Spermiducal glands with a straight duct furnished with terminal sac. No egg-sacs. Hab.—Zebu.*

This species is near to *P. vaillanti;* it differs, however, from that species in a few small points; *P. vaillanti* has no thickened septa, there are four pairs of spermathecae and the male duct is bent into a horseshoe shape. Is *P. dubia* of HORST (**17**) synonymous?

(47) Perichaeta capensis, HORST.

P. capensis, HORST, Zool. Ergebn. Ost-Indien, p. 62.

P. operculata, ROSA, Ann. k. Hofm. Wien, Bd. vi, 1891, p. 398.

Megascolex capensis, HORST, Notes Leyd. Mus., v, 1883, p. 195.

Definition. *Length,* 70 *mm.; breadth,* 5 *mm.; number of segments,* 60. *Clitellum, XIV–XVI. Male pores on large papillae, appearing as if partly covered by an operculum, since the aperture is crescentic, separated by* 8–10 *setae. There are no papillae. Setae,* 38–40 *on segment VIII,* 50 *posteriorly. Dorsal pores commence on VIII/IX (XI/XII). Spermathecae in VIII, IX; diverticulum long and coiled like a ram's horn tapering towards extremity. Spermiducal glands extend through segments XV–XXI, with short duct. Hab.—Java; Cape of Good Hope.*

This species is stated to be 'flesh-coloured, with brown clitellum.' The buccal segment is not separated from the following. There are some of the septa which are specially thickened, but ROSA does not exactly state which; all those in front of the eighth segment are thickened, but it is not said how many these amount to.

In spite of the difference in habitat, HORST is of opinion that his *Megascolex capensis* is the same species as ROSA's *P. operculata,* and UDE (**4**) concurs.

(48) Perichaeta vaillanti, Beddard.

P. vaillanti, Beddard, P. Z. S., 1890, p. 66.

Definition. *Clitellum, XIV–XVI, without setae. Dorsal pores present. No specially thickened septa. Spermathecae in VI–IX, with short diverticulum. Spermiducal glands with a large terminal sac. Hab.—Luzon.*

This species is also characterized by its peculiar sperm-sacs (see Pl. v, fig. 10 of memoir). There are two pairs of sacs in segments xi, xii; from each a tubular outgrowth arises which perhaps meets its fellow in the middle line above the intestine. I have illustrated the sperm-sacs. *P. vaillanti* comes very near to *P. enganensis*, but the relative length of the spermathecal diverticulum distinguishes them.

(49) Perichaeta sumatrana, Horst.

Megascolex sumatranus, Horst, Notes Leyd. Mus., vol. v, 1883, p. 189.
P. sumatrana, Horst, Midden Sumatra, Vermes, 1892, p. 5.

Definition. *Length,* 70 *mm.; breadth,* 4 *mm.; number of segments,* 94. *Clitellum, XIV–XVI, without setae. Setae* 38–44 *per segment, in front of and behind clitellum. Intestine begins in XIV. Spermathecae in VIII, IX. Spermiducal glands with terminal sac. Hab.—Sumatra; Hong Kong; Barbadoes.*

I am not quite certain, as I pointed out at the time, that the species which I described **(55)** as *P. sumatrana* is the same as Horst's species. In my *Perichaeta* the spermathecae are a segment in front of the position that they are stated to occupy by Horst in his latest note **(17)** upon the species. The worms seen by myself vary somewhat in colour; one individual (figured in colour) was of a bright green marked with lighter bands; in the others the green was replaced by an olive brown.

(50) Perichaeta pentacystis, Rosa.

P. pentacystis, Rosa, Ann. k. Hofm. Wien, Bd. vi, 1891, p. 400.

Definition. *Length,* 110 *mm.; breadth,* 6 *mm.; number of segments,* 82. *Clitellum, XIV–XVI. Male pores correspond to eighteenth seta. Genital papillae on segments VIII, XVII, XVIII; a pair on each. Number of setae on the middle segments of the region in front of the clitellum about* 100. *Dorsal pores commence XIV/XV. Gizzard in VIII; intestine begins in XV (? as to caeca). Septa IV/VII and XI/XII thickened; septa VII/IX present but delicate; blood-glands found in the first seven segments.*

Last pair of hearts in XIII. Five pairs of spermathecae in V–IX; they are round and flattened with a long diverticulum terminating in a dilated extremity. Sperm-sacs in XI, XII; the sperm-reservoirs are in X, XI. Spermiducal glands very lobate extending through three segments. Hab.—Island of Mahe.

A peculiarity of this species is the arrangement of the spermathecae; the first three pairs open anteriorly in their segment, the last two posteriorly; it follows, therefore, that segment seven has two spermathecae on each side. This arrangement is found in *Allolobophora transpadana*, and *A. complanana*. The large number of spermathecae is only found in *P. violacea* (of *Perichaetae*, s. s.).

(51) Perichaeta acystis, Beddard.

P. biserialis, Beddard, P. Z. S., 1890, p. 63.

Definition. *Clitellum, XIV–XVI, without setae. Male pores wide apart; behind them, on five following segments, are papillae occupying a corresponding position. Setae on either side of ventral median line much enlarged. Dorsal pores present. Septa VI–IX, thickened. Spermathecae absent. Hab.—Luzon.*

This species, of which I am able to give only an incomplete account, was at first identified by myself with Perrier's *P. biserialis;* I do not, however, now think that that supposed identity can be maintained. *P. biserialis* of Perrier has two pairs of spermathecae, while the present species has none; as I examined two specimens the absence of spermathecae can hardly be regarded as accidental.

(52) Perichaeta forbesi, Beddard.

P. forbesi, Beddard, P. Z. S., 1890, p. 65.
P. sp., Beddard, Zool. Anz., 1889, p. 534.

Definition. *Length, 230 mm.; breadth, 12mm. Clitellum, XIV–XVI, with setae on ventral side of all segments. Male pores wide apart; on XVII and on XIX–XXI are a pair of papillae. Dorsal pores commence XII/XIII. Septa VII/VIII, X/XII, thickened. Sperm-sacs in XII. Egg-sacs in XIV. Spermathecae in VIII, IX. Hab.—New Guinea.*

In both of the two individuals of this species which I have examined, one spermatheca was doubled; in one case it was the left-hand pouch of the eighth segment; in the other the corresponding pouch of the next segment. The sperm-sacs appear to be peculiar; the single pair are attached to the septum xi/xii; above each of these was a pedunculated sac, attached separately to the septum, and entirely filled with Gregarines.

(53) **Perichaeta posthuma,** VAILLANT.

P. posthuma, VAILLANT, Ann. Sci. Nat., 1868, p. 228.

P. affinis, PERRIER, Nouv. Arch. Mus., 1872, p. 106.

Megascolex affinis, BEDDARD, Ann. Mag. Nat. Hist. Oct., 1883, p. 214.

Definition. *Length,* 60 *mm.; number of segments,* 116. *Clitellum, XIV–XVI, with complete or incomplete rows of setae. Male pores preceded and followed (on segments XVII, XIX) by papillae occupying a corresponding position. Male pores separated by* 26 *setae. Setae,* 140 *on VIII;* 108 *on X; further back,* 90. *Septa, V/IX thickened. Spermathecae in VI–IX with a diverticulum as long as pouch, tubular. Hab.—Celebes; Philippines; India; Bahamas.*

I fully agree with HORST that PERRIER'S *P. affinis* is the same as VAILLANT'S *P. posthuma;* but HORST, in my opinion, is slaying the slain in showing, as he does in his most recent contribution to the anatomy of earthworms, that *P. posthuma,* in this event, cannot be confounded with *P. indica.* It is, as he remarks, a stouter species, and the papillae in the neighbourhood of the male pores are highly distinctive. The species is one of the commonest of the genus, and one obtains it in all collections from the East. I have described a curious variation which this species sometimes shows, in the presence of three separate spermathecae[1] in one segment and on one side of the body. I have also noted a displacement of the papillae, so that on one side there was an unpaired papilla in front, and on the other side an unpaired papilla behind. In another specimen there were the two normal pairs of papillae and an additional one upon the twentieth segment on the right side. I only found setae upon the clitellum on the ventral surface of the organ, but HORST confirms the earlier statement of PERRIER that there are complete circles of setae on the clitellar segments.

(54) **Perichaeta houlleti,** PERRIER.

P. houlleti, PERRIER, Nouv. Arch. Mus., 1872, p. 99.

P. campanulata, ROSA, Ann. Mus. Civ. Genova, vol. x (2a), 1890, p. 115.

Definition. *Length,* 200 *mm. Clitellum, XIV–XVI, with complete rows of modified setae (sixty in each) thereon. Male pores separated by twelve setae. Setae, IV,* 30*; IX,* 49*; XIII,* 54*; those nearest to ventral line rather longer than the others. Dorsal pores commence XI/XII. Intestine commences in XV. The first septum divides segments V/VI; this and the succeeding two are thickened; so are septa X/XIII. Spermathecae in VII–IX,*

[1] I have met with a similar variation in an undetermined species from British Guiana.

with a zigzag diverticulum and one or two copulatory glands opening into long duct of spermatheca. Spermiducal glands extend through XVI–XXII. Hab.—India; Cochin China; Philippines; Bahamas.

This species is one of the few that has been investigated by a considerable number of observers. Perrier (**3**), Horst (**17**), Rosa (**9**), Bourne (**3**), and I (**62**), have combined to collect a considerable number of details about the anatomy of *P. houlleti.* Our knowledge of the species appears to me to show that Horst is perfectly right in declining to recognize Rosa's species, *P. campanulata* as valid; the differences upon which Rosa relied are the shape of the gizzard and the dilated oesophagus which precedes it; these points, however, are simply corrections by Rosa of the more inaccurate descriptions of his predecessors. The most obvious character by which this species can be distinguished is, of course, the unique form of the clitellar setae. Perrier gave a more detailed account of this species than of any other, and his paper, as well as the others quoted, contains figures of all the important anatomical characters. I have dealt in many places in the present work with these characters (see index), and, therefore, need not now give any further account of the species.

I have occasionally observed an irregularity in the setae, the line of their implantation being not perfectly straight.

I very much doubt whether *P. udekemi* of Michaelsen from Java is really different.

(55) Perichaeta musica, Horst.

Megascolex musicus, Horst, Notes Leyd. Mus., v, 1883, p. 193.
P. musica, Horst, ibid., xii, 1890, p. 236.

Definition. *Length,* 570 *mm.; number of segments,* 66. *Clitellum without setae. Male pores on a line with sixteenth seta. Setae,* 100 *to each segment; a very small dorsal gap. Dorsal pores commence XII/XIII. Intestine often with six caeca. Septa X/XIII, thickened. Spermathecae in VII, VIII, each with a long coiled diverticulum longer than pouch. Hab.—Java.*

This, the largest species of Perichaeta and one of the largest of earthworms, has been figured by Vorderman. Its colour when alive is greyish blue above, rufous below; the clitellum is brownish. It is stated to produce a sound during the night, probably caused by the setae coming into contact with pebbles. It is the only species not Japanese which has six caeca on the intestine, but this character is not always met with.

(56) **Perichaeta annulata,** HORST.

Megascolex annulatus, HORST, Notes Leyd. Mus., v, 1883, p. 195.
P. annulata, HORST, ibid., xii, 1890, p. 236.

Definition. *Length,* 195 *mm.; number of segments,* 130. *Setae about* 65 *per segment. Spermathecae in VII, VIII, globular, with a slender diverticulum half the length of pouch. Spermiducal gland confined to segment XVIII. Hab.—Malayan Archipelago.*

This is not a well-defined species, and, were it not for HORST'S experience of the earthworms coming from this region, I should be disinclined to allow it. As, however, he speaks of it by this name so lately as 1890, in which paper the spermathecae are figured, and 1892 (**17**), it is probably distinct from the large number of other species coming from this part of the world.

(57) **Perichaeta hasselti,** HORST.

Megascolex Hasselti, HORST, Notes Leyd. Mus., v, 1883, p. 190.
P. hasselti, HORST, Midden Sumatra Vermes, 1892, p. 5.

Definition. *Length,* 70 *mm.; number of segments,* 100. *Setae,* 70–75 *in each segment; on ventral side about* 40 *stand in a dense row, those more dorsally placed being separated by greater interspaces. Spermathecae in VI, VII, with conical diverticulum half the length of pouch. Spermiducal glands extending over five segments (XVII–XXII). Hab.—Lebong, Sumatra.*

The most characteristic feature of this species is the crowding together of a number of the setae on the ventral surface of the body; this aggregation of setae is accompanied by a thickening of the circular muscles. The position of the spermathecae is, perhaps, not correctly stated in the above diagnosis, as HORST puts the sperm-duct funnels as being in segments xi, xii, which is, of course, unlikely. The lobed spermiducal glands are compared by HORST to the lobed kidney of a seal. These glands, the spermathecae, and a section through the body-wall, showing the crowded setae and the thickened circular muscular layer, are figured by HORST.

(58) **Perichaeta japonica,** HORST.

Megascolex japonicus, HORST, Notes Leyd. Mus., v, 1883, p. 192.

Definition. *Length,* 220 *mm. Male pores situated on a long groove of the shape of a* J, *which extends over segment XVIII and a part of XVII. Number of setae in each segment,*

66. Spermathecae two pairs in VII, VIII, with slender diverticulum half the length of pouch. Spermiducal glands extending through segments XVII–XIX. Hab.—Japan.

This species has been rather imperfectly described by HORST; it does not, however, seem to be identical with any other form described from Japan. The nearest is, perhaps, *P. tokioensis.* The main difference between the species appears to be the J-shaped ridge in the present worm.

(59) Perichaeta indica, HORST.

Megascolex indicus, R. HORST, Notes Leyd. Mus., v, 1883, p. 186.
P. indica, BEDDARD, P. Z. S., 1886, p. 298.
P. heterochaeta, MICHAELSEN, Abh. nat. Ver. Hamb., xi, Heft 2, p. 1.
Megascolex diffringens, VAILLANT, Bull. Soc. Philom. Paris, 1870, p. 385.
P. diffringens, VAILLANT, Annelés, p. 73.

Definition. *Length,* 150 *mm.; number of segments,* 100. *Clitellum, XIV–XVI, without setae. Setae,* 42–48 *per segment, those on ventral side in anterior segments being much larger than the others. Dorsal pores commence XII/XIII. Genital papillae on VI, VII, VIII, near to orifices of spermathecae. Spermathecae, four pairs in VI–IX, with tubular diverticulum. Spermiducal glands. Hab.—India; Java; Sumatra; South America; Azores; New Caledonia; Europe.*

This species is one of the commonest of the genus. It frequently occurs in hot-houses in Europe, having been there met with in Scotland by SERVICE, and by MICHAELSEN in Berlin. The living worm is of a fine rich brown colour, with a distinct white line at the implantation of the setae. I have given a figure of the living worm (**56**, Pl. iv, fig. 1). The spermatheca has been figured by HORST, who has indicated the occasional presence of a branch of the spermathecal diverticulum. The species was first of all described by HORST (**20**) without a name; in this paper all the important structural characters are illustrated.

It is very possible that VAILLANT'S '*P. diffringens,*' which he describes as of a brown colour and with four pairs of spermathecae, is this species.

(60) Perichaeta vitiensis, BEDDARD.

P. vitiensis, BEDDARD, Ann. Mag. Nat. Hist., Feb. 1892, p. 131.

Definition. *Length,* 75 *mm.; number of segments,* 70. *Clitellum, XIV–XVI, without setae. Male pores separated by about six setae. Dorsal pores commence XI/XII. Behind the gizzard four thickened septa. Spermathecae in VIII, with one diverticulum. Funnels*

of sperm-ducts (and testes?) single. Spermiducal glands lie in XVII–XIX, with small terminal sac. Hab.—Viti.

This species appears to be quite distinct on account of the possession of only one pair of funnels; but as I had only a single specimen at my disposal, which forms part of the collection in the Vienna Museum, I was naturally obliged to dissect it with great care. It is therefore possible that an error has been made in this particular, as the possession of two pairs of funnels and testes appears to be one of the marked characters of the Perichaetidae. I suggested that this species may, perhaps, be the same as GRUBE'S *P. subquadrangula*, which comes from the same locality. But GRUBE'S description is not sufficient to enable me to decide the point.

(61) Perichaeta everetti (NEW SPECIES).

Definition. *Length, about* 300 *mm.; diameter,* 12 *mm.; number of segments,* 190. *Clitellum, XIV–XVI, without setae. Male pores separated by sixteen setae. On each of segments XIX–XXI a pair of long narrow papillae just in front of line of setae. Their length is equivalent to about eight setae, and they are separated (the pair of each segment) by about an equal number. Dorsal pores commence XII/XIII. Gizzard in VIII. Septa IV/VIII, XI/XIV thickened. No caeca. Last hearts in XIII. Spermathecae in VI/VII; twelve and seventeen respectively; the number of the diverticula appears to correspond. Hab.—Mount Kina Balu.*

This species is very near to *P. stelleri*. They may prove to be identical. In the meantime the number of spermathecae is different, and the genital papillae seem to be rather different. The present species has a reddish purple colour dorsally; the egg-sacs (in segment xiv) are very large; a pair of sacs in xiii close to ovaries may be a second pair.

(62) Perichaeta papillata (NEW SPECIES).

Definition. *Length,* 500 *mm.; diameter,* 7 *mm. Clitellum, XIV–XVI, without setae. Male pores separated by ten setae; on each of ten following segments a pair of papillae in front of line of setae; closer to middle line than male pores. Dorsal pores commence XII/XIII. Septa IV/VIII, IX/XIII thickened. Caeca absent. Last hearts in XII. Spermathecae in VI, VII; seven in each segment; each has a small coiled diverticulum ending in an oval sac. Sperm-sacs in XI, XII; egg-sacs in XIII. Spermiducal glands extend through three segments, without terminal muscular sac. Hab.—Merabah, N. Borneo.*

The length of this species is probably not natural; it was much softened. I

observed two distinct oviducal pores opening upon the common area. On the clitellum there are three lines marking the place where the setae should be. It is probably not a matter of much importance, but the spermatheca were arranged thus, VI, 3–4; VI, 4–3.

(63) Perichaeta sarawacensis (NEW SPECIES).

Definition. *Length about* 300 *mm.; diameter,* 7 *mm.; number of segments,* 260. *Clitellum, XIV–XVI, without setae. Male pores followed by four pairs of papillae on following segments. Dorsal pores commence XII/XIII. Caeca absent. Septa V/VIII, X/XIV, thickened. Last pair of hearts in XIII. Spermathecae in VI, VII, about fourteen in each with diverticula as in* P. everetti. *Sperm-sacs in X, XI, XII; egg-sacs in XIII. Spermiducal glands rather diffuse extending through three segments. Hab.—Sarawak.*

This species does not show the purple colouration of its allies. It is apparently intermediate between *P. everetti* and *P. papillata*. The papillae are like those of the latter though not so numerous; the internal structure is more like that of *P. everetti*.

(64) Perichaeta kinabaluensis (NEW SPECIES).

Definition. *Length,* 150 *mm.; diameter,* 9 *mm.; number of segments,* 200. *Clitellum, XIV–XVI, without setae. Male pores separated by sixteen setae; on XIX and XX a single median papillae, like those of* P. everetti *fused; on XXI the left half only developed. Dorsal pores commence XI/XII. Gizzard in VIII; no caeca. Septa V/VIII, X/XIV thickened. No septum missing. Last hearts in XII. Spermathecae in VI, VII; eleven and seventeen in each; the diverticula as in* P. everetti. *Sperm-sacs in X, XI, XII. Egg-sacs in XIII. Spermiducal glands large and compact though limited to one segment, the septa of which are bulged out to make room for it; without terminal muscular sac. Hab.—Tamburungare, Kina Balu, Borneo, at an altitude of* 7,700 *ft.*

This species comes nearest to *P. everetti*. It has (in spirit) the same purple red colour above with white lines where the setae are unplanted. A few slight differences will be recognizable from the above description.

(65) Perichaeta upoluensis, BEDDARD.

P. upoluensis, BEDDARD, P. R. Soc. Edin., vol. xiv, 1886, p. 174.

Definition. *Length, about five inches. Clitellum XIV, XV. Genital papillae one on each of segments IX, XVI–XX; on XVIII in addition a pair of papillae to inside of male*

pores; on XIX a pair of papillae just behind and to outside of male pores. Spermathecae in VIII, IX each with a diverticulum. Sperm-sacs in XI, XII. Last heart in XIII. Hab.—Upolu.

I have commented above as to the limited clitellum which exists apparently in this and in some other species. The genital papillae seem to be particularly small.

(66) Perichaeta aspergillum, Perrier.

P. aspergillum, Perrier, Nouv. Arch. Mus., 1872, p. 118.
Megascolex aspergillum, Vaillant, Annelés, p. 76.
non **P. aspergillum**[1], Beddard, Q. J. M. S., vol. xxviii, 1888, p. 401.

Definition. *Length*, 370 *mm. Clitellum, XIV–XVI, with setae on all its segments. Setae, eighty in number on certain of the segments. Papillae grouped in masses of nine to eleven in proximity to male pores and to spermathecal pores. Spermathecae, two pairs in VII, VIII. Hab.?*

This species comes nearest to *P. bermudensis* under the description of which the differences are noted.

(67) Perichaeta biserialis, Perrier.

P. biserialis, Perrier, C. R., 1875, p. 1044.
Megascolex biserialis, Vaillant, Annelés, p. 76.

Definition. *Clitellum, XIV–XVI*[2]. *Setae absent on ventral median line, which is bordered by a large seta on each side. Papillae, seven pairs on XIX–XXV. Spermathecae, two pairs. Hab.—Philippines.*

I have already (p. 422) commented upon the nearness of this species to my *P. acystis*.

(68) Perichaeta robusta, Perrier.

P. robusta, Perrier, Nouv. Arch. Mus., 1872, p. 112.
Megascolex robustus, Vaillant, Annelés, p. 76.

Definition. *Length*, 180 *mm. Clitellum, XIV–XVI. Setae*, 45 *per segment. Between the male pores are a pair of papillae. Spermathecae, two pairs in VIII, IX. Hab.—Mauritius; Manilla.*

[1] This is *P. bermudensis* (q. v.).
[2] Perrier merely states that the clitellum occupies three segments.

(69) Perichaeta elongata, PERRIER.

P. elongata, PERRIER, Nouv. Arch. Mus., 1872, p. 124.
Megascolex elongatus, VAILLANT, Annelés, p. 81.

Definition. *Length,* 355 *mm. Clitellum, XIV–XVI. One pair of spermathecae in VI. Hab.—Peru.*

Insufficient though the data given by PERRIER about this species are, the number and position of the spermathecae appear to distinguish it.

(70) Perichaeta quadragenaria, PERRIER.

P. quadragenaria, PERRIER, Nouv. Arch. Mus., 1872, p. 122.
Megascolex quadragenarius, VAILLANT, Annelés, p. 81.

Definition. *Length,* 210 *mm.; number of segments about* 100. *Clitellum, XIV–XVI. Setae,* 40 *in number on some of segments. Spermathecae, one pair in VII. Hab.—E. Indies.*

(71) Perichaeta falcata, HORST.

P. falcata, HORST, Notes Leyd. Mus., xv, 1893, p. 316.

Definition. *Length,* 120 *mm.;* 60 *setae to anteclitellian segments. Clitellum without setae. Dorsal pores begin behind clitellum. Spermathecae in VIII, IX with diverticulum as long as pouch. Spermiducal gland with dilated terminal sac. Hab.—Flores.*

(72) Perichaeta variabilis, HORST.

P. variabilis, HORST, loc. cit., p. 319.

Definition. *Length,* 160 *mm.;* 54 *setae in segments in front of and behind clitellum. Clitellum without setae. Male pores separated by eight setae. Dorsal pores begin behind clitellum. Spermathecae in VIII, IX with long coiled diverticulum. Sperm-sacs in XI, XII. Hab.—Soemba.*

This species is named on account of its variability; the spermiducal gland was found in three of the four specimens examined to be very feebly developed as in the majority of the Japanese *Perichaetae.* The diverticulum of the spermathecae also differs in length.

(73) Perichaeta tenkatei, Horst.

P. tenkatei, Horst, loc. cit., p. 321.

Definition. *Length,* 85 *mm.; number of segments,* 100; 50 *setae in segments near to clitellum. Clitellum without setae. Dorsal pores begin XI/XII. Spermatheeae in VIII, IX with long* U-*shaped diverticulum longer than pouch. Spermiducal glands terminating in a small dilated sac. Hab.—Soemba.*

This species has the male pores upon large papillae, and there is a kind of lid to each pore as in *P. capensis*. Above the ovaries in xiii is apparently an egg-sac.

(74) Perichaeta urceolata, Horst.

P. urceolata, Horst, loc. cit., p. 322.

Definition. *Length,* 110 *mm.;* 36–40 *setae upon each segment. Clitellum without setae. Male pores separated by twelve setae. Spermiducal glands with terminal sac. Hab.—Sumatra.*

This species is unusual in having only a single pair of spermathecae; but in one specimen there was additional though much smaller pair in vii. The pouch was found by Horst to contain 'sand and other strange material.'

(75) Perichaeta bosschae, Horst.

P. bosschae, Horst, loc. cit., p. 324.

Definition. *Length,* 170 *mm.; number of segments,* 125. *Dorsal pores begin XII/XIII. Clitellum without setae. Spermathecae in VI–IX with small diverticulum. Hab.—Borneo.*

(76) Perichaeta tijibodae, Horst.

P. tijibodae, Horst, loc. cit., p. 326.

Definition. *Length,* 50 *mm. Setae,* 44 *per segment. Clitellum without setae. Male pores separated by eight setae. Spermathecae in VIII, IX, with diverticulum curved like a ram's horn. Spermiducal gland extends over segments XVI–XXII; it has a terminal sac. Last hearts in XIII. Hab.—Tijibodas, Java.*

This species evidently, as Horst points out, comes very near to *P. capensis*, The principal difference appears to be the length and coiling of the duct of the

spermiducal gland in this species; in *P. operculata* of Rosa, which = *P. capensis* of Horst, the duct is short and straight.

(77) Perichaeta inflata, Horst.

P. inflata, Horst, loc. cit., p. 327.

Definition. *Length, 55 mm. No setae on clitellum. Spermathecae in VIII, IX with a long twisted diverticulum ending in a pyriform dilatation. Spermiducal gland terminating in a sac. Hab.—Tijibodas, Java.*

(78) Perichaeta pusilla, Ude.

P. pusilla, Ude, Z. wiss. Zool., 1893, p. 63.

Definition. *Length, 16 mm.; number of segments,* 60[1]. *Setae,* 40–50 *per segment. Twelve setae on last clitellar segment. Male pores separated by ten setae. Genital papillae paired on XVII and XIX, one on XX. Spermathecae in VI with small spherical diverticulum. Hab.—Buitenzorg, Java.*

(79) Perichaeta parva, Ude.

P. parva, Ude, loc. cit., p. 64.

Definition. *Length, 25 mm.; number of segments,* 85. *Setae,* 40–44. *First dorsal pore X/XI. Male pores separated by twelve setae. Spermathecae in VIII, IX with very long diverticulum which widens gradually and then suddenly narrows, widening again into an oval sac. Hab.—Tijibodas, Java.*

Genus PLEIONOGASTER, Michaelsen.

Syn. **Perichaeta,** Beddard (in part.).

Definition. Setae forming continuous rows, very numerous (150–160) on some of anterior segments. Clitellum, XIII–XVII, with setae. Gizzard in VIII, and three or four posterior gizzards in region of twenty-seventh and following segments; no caeca. Spermiducal glands lobate, without penial setae.

The type-species of this genus was described by myself (**41**) some years ago, and referred to the genus *Perichaeta*. Later, Michaelsen (**10**) described two other species, which

[1] The single specimen was incomplete.

he proposed to include in a new genus, *Pleionogaster*. I have already (p. 365) discussed the genus. The species are all from the Philippines, and may be thus distinguished:—

Gizzard well developed . . . . **P. horsti.**
Gizzard more or less rudimentary:
  Four accessory gizzards . . . . **P. jagori.**
  Three accessory gizzards . . . . **P. samariensis.**

(1) Pleionogaster horsti (BEDDARD).

Perichaeta horsti, BEDDARD, P. Z. S., 1886, p. 300.

Definition. *Length*, 73 *mm.; breadth*, 4 *mm.; number of segments, about* 200. *Setae*, 67 *in segment II; thence increasing up to segment VI* (151)*; gradually diminishing to* 72 *in segment XII; in hinder region of body only* 52 *per segment. Clitellum, XIV–XVII; continuous rings of setae on all its segments. Dorsal pores present. Three papillae, one median and two lateral, on segments XVI, XVII, XIX, XX, XXI, and XXII. On XVIII median papilla alone present; male pores occupying the position of lateral papillae. Gizzard in VIII; oesophagus from IX–XVI, with much-folded and vascular walls; intestine begins in XIX; in segments XXVI–XXVIII* (*about*) *three accessory gizzards. First septum, IV/V; four following greatly thickened. Spermathecae in VIII and IX, with a short tubular diverticulum. Hab.—Neighbourhood of Manila.*

(2) Pleionogaster jagori, MICHAELSEN.

P. Jagori, MICHAELSEN, Arch. f. Nat., 1892, p. 247.

Definition. *Length*, 170 *mm.; breadth*, 5 *mm.; number of segments*, 270 (*about*). *Setae very numerous on anterior segments:* 150 *on X; only* 84 *on XXI. Clitellum, XIV–XVII; on the last segment only, on upper side of body. Dorsal pores commence XII/XIII. Male pores separated by two setae; two pairs of genital papillae on intersegmental furrows XVII/XVIII, XVIII/XIX, on a level with the male pores. Gizzard in VIII; accessory gizzards, four in segments XXVII–XXXIII. The anterior septa, as far as, and including, VIII/IX, thickened. Sperm-sacs in XI, XII. Spermathecae as in last species. Hab.—Daraga, Luzon.*

(3) Pleionogaster samariensis, MICHAELSEN.

P. samariensis, MICHAELSEN, loc. cit., p. 248.

Definition. *Length*, 75 *mm.; breadth*, 3 *mm.; number of segments*, 230. *Setae*, 160 *on X;*

74 on XXI. Between male pores, eight setae. Two pairs of genital papillae as in last species. Gizzard not recognizable; three accessory gizzards behind. Hab.—Loquilocun, Samar.

Neither of these species differs widely from *P. horsti.* The chief difference appears to be the rudimentary gizzard of the two last species (only to be seen in sections), contrasting with the conspicuous gizzard of *P. horsti.*

Genus PERIONYX, PERRIER.

Syn. **Megascolex,** VAILLANT (in part.).

DEFINITION. Ring of setae continuous, present upon all segments of clitellum. Clitellum, XIII–XVI (XVII, XIX). Male pores closely approximated, with or without specialized setae in their neighbourhood. No caeca. Dorsal pores commence V/VI. Spermathecae, two or three pairs in (VII) VIII, IX. Nephridia paired. Spermiducal glands lobate.

This genus has been referred by BENHAM (**1**) to a distinct family; but in my opinion this step is as erroneous, on the one hand, as is VAILLANT'S refusal, on the other hand, to allow it generic separation from *Perichaeta.*

BENHAM indeed, in his phylogenetic scheme (p. 280) puts the Perionycidae nearly as far away from the Perichaetidae as is possible; they only come together at the very commencement of the series, diverging immediately. But this is due to his separating (in my opinion quite wrongfully) certain of my Cryptodrilidae from others. No doubt *Perionyx* does bear resemblances to *Plutellus, Pontodrilus,* &c.; but if, as I think we inevitably must, we regard *Plutellus* as nearer to *Typhoeus* than to *Eudrilus,* and place *Perichaeta* in the neighbourhood of the two former genera, it is unnecessary to assume that the complete circle of *Perionyx* has been independently acquired, even granting for the moment that that condition is secondary.

Besides the points mentioned in the above diagnosis of the genus, it may be distinguished from *Perichaeta* or from *Megascolex* by a number of other characters; in the first place, there are no specially thickened septa; the presence of these structures is so very usual that their absence gets, perhaps, an undue importance. In having paired nephridia, this genus resembles *Diporochaeta,* and differs from all other Perichaetidae.

The most interesting fact in the anatomy of the genus concerns the genital setae in the neighbourhood of the male pores; in two species, at any rate, there is a group of long setae with a very marked ornamentation at the free extremity near

to each spermiducal pore; these setae, however, do not form an irregular group; they are arranged in a line which is perfectly continuous with the line of setae on the rest of the segment. These setae have a more marked ornamentation than the setae of surrounding segments; as in many Geoscolicidae, the remaining setae of the body show, here and there at all events, an ornamentation; the presence of these genital setae was first pointed out by MICHAELSEN (**13**); I showed later that they existed in *P. excavatus* as well as in *P. gruenewaldi;* in the two other species of the genus which are at all adequately known there are no specially modified setae in the neighbourhood of the male pores; such setae as there are do not differ in any marked way from the ordinary setae of the body. The close approximation of the two male pores is also seen in the case of the spermathecal orifices; the spermathecae themselves are, except in *P. saltans* and *P. sansibaricus*, two pairs only; in six species, viz. *P. gruenewaldi*, *P. violaceus*, *P. sansibaricus*, *P. arboricola*, *P. saltans*, and *P. intermedia*, the spermathecae have diverticula which are (more usually) small and sessile upon the duct of the spermathecae; in *P. macintoshii* there is a diverticulum even more rudimentary; I have not found a diverticulum in *P. excavatus*, and it is stated by ROSA to be missing. There are eight species of the genus, which is confined to the tropics of the Old World.

(1) Perionyx excavatus, PERRIER.

P. excavatus, PERRIER, Nouv. Arch. Mus., 1872, p. 126.

Megascolex excavatus, VAILLANT, Annelés, p. 69.

Definition. *Length,* 110 *mm.; breadth,* 4 *mm.; number of segments,* 165. *Colour (in spirit) purplish on dorsal surface, yellow beneath; clitellum yellowish brown. Clitellum, XIII (XIV)–XVII. Setae,* 25–50 *in number per segment. Male pores on two papillae, which are enclosed in an area; on either side of each a row of about five longer penial setae. Gizzard very slight in VII. A pair of calciferous glands in XIII. Intestine begins in XVII. Last pair of hearts in XII. Hab.—India; Luzon.*

This is the type-species of the genus; the chief mark of distinction between this and other species is in the form of the papillae which bear the male pores, and in the genital setae which accompany these orifices. The male pores are each placed upon a semicircular elevation, the two being in close contact. These flat papillae are both depressed below the surface of the surrounding integument, the depression being marked anteriorly and posteriorly, but not laterally, by grooves. Not only the setae of the eighteenth segment are modified, but those of neighbouring segments, particularly the nineteenth, to some extent.

See, in addition to above-quoted references, BEDDARD (**41**) and ROSA (**9**). The species is illustrated by PERRIER.

(2) Perionyx intermedius, BEDDARD.

P. intermedius, BEDDARD, P. Z. S., 1892, p. 689.

Definition. *Length*, 105 *mm.; diameter*, 5 *mm.; number of segments*, 117. *Colour, a much fainter purple dorsally than is usual. Clitellum, XIII–XVII. The depression upon which the male pores open is shallow; there are a pair only of setae on this area which may or may not be modified. Gizzard in VI, not well developed; calciferous glands absent; intestine begins in XVIII. Last heart in XIII. Spermathecae two pairs, each with a small globular sessile diverticulum. Spermiducal glands of loose texture extending through segments XVII–XIX. Hab.—Seebpore.*

In the specimens which I have studied the two setae in the area of the male-pores had their points broken off; it cannot therefore be said whether they were ornamented or not; in any case they were not different in form from those elsewhere.

(3) Perionyx gruenewaldi, MICHAELSEN.

P. gruenewaldi, MICHAELSEN, JB. Hamb. wiss. Anst., viii, 1891, p. 33.

Definition. *Length*, 85 *mm.; diameter*, 3 *mm.; number of segments*, 158. *Clitellum, XIII–XVII. Setae, fifty per segment in the middle of the body, more crowded ventrally. Dorsal pores commence IV/V. Area upon which male pores open bounded by a groove; four genital setae on each side, ornamented as in* P. excavatus. *Gizzard rudimentary in VI; dilatation in XIII corresponding to calciferous glands on other worms. Intestine begins in XIII. Spermathecae two pairs, with one or several small diverticula. Sperm-sacs in X–XII. Spermiducal glands limited to XVIII. Hab.—Sangir.*

MICHAELSEN describes a gizzard in segment xiv, but HORST (**17**) apparently did not find anything of the kind, though he does not actually contradict MICHAELSEN in the matter. The small gizzard of segment vi was overlooked by MICHAELSEN.

(4) Perionyx violaceus, HORST.

P. violaceus, HORST, Zool. Ergebn., Ost-Indien, Bd. ii, p. 72.

Definition. *Length*, 55 *mm.; number of segments*, 115. *Clitellum, XIII–XVII (and the ventral side of XVIII). Dorsal pores commence IV/V. Number of setae in segments in vicinity of clitellum*, 40–50—*more crowded on the ventral surface of the body;*

a dorsal median gap. Gizzard feebly developed in VI; a dilatation in XIII, which is probably a calciferous gland. Spermathecae in VIII, IX, each with a small stalked pyriform appendix. Spermiducal gland limited to segment XVIII. No penial setae. Hab.—Java; Sumatra.

HORST remarks about this species that it is possible to distinguish the nephridia lying anterior to the eighteenth segment by the fact that the excretory tube is more highly developed than in the rest of the body. I have had a specimen of either this or the last (my notes are imperfect) from Durban.

(5) Perionyx macintoshii, BEDDARD.

P. M'Intoshii, BEDDARD, Ann. Mag. Nat. Hist., Oct. 1883, p. 217.

Definition. *Length,* 249 *mm.; diameter,* 9 *mm.; number of segments,* 261. *Clitellum, XIII–XIX. Dorsal pores commence V/VI. Male pores upon an oval depression* 3 *mm. wide, behind setae which are but little modified. Gizzard in VI; intestine begins in XIX. Last hearts in XIII. Sperm-sacs in X–XII. Spermathecae without diverticulum, two pairs. Hab.—India; Burmah.*

The first individual of this species that I examined was immature; hence there is a possibility that it is not really the same as some specimens (**57**) from either Seebpore or Darjiling (unfortunately I have mislaid my notes relative to the locality); in the meantime its large size is a feature which characterises both and distinguishes them from any other form. The mature examples are further to be differentiated by the extensive clitellum.

(6) Perionyx arboricola, ROSA.

P. arboricola, ROSA, Ann. Mus. Civ. Genova (2a), x, 1890, p. 119.

Definition. *Length,* 70 *mm.; diameter,* 5 *mm.; number of segments,* 110. *Clitellum, XIV–XVI. Setae,* 56–60 *per segment, much closer ventrally. Dorsal pores commence V/VI. Gizzard small in V. Spermathecae in VI, VII, VIII, IX, with a tubular diverticulum. Spermiducal glands enormous, occupying nine segments. Hab.—Burmah.*

(7) Perionyx sansibaricus, MICHAELSEN.

P. sansibaricus, MICHAELSEN, JB. Hamb. wiss. Anst., ix, 1892, p. 4.

Definition. *Length,* 63 *mm.; diameter,* 3 *mm.; number of segments,* 108. *Clitellum, XIII–XVII. Setae,* 40 *per segment in front of clitellum,* 50 *behind. Dorsal pores*

commence VIII/IX. Gizzard doubtful (? rudimentary in VI as in other species); calciferous gland in XIII. Nephridia alternate in position; ventral series with a short terminal sac, dorsal series with a long sac. Spermathecae in VII, VIII, IX, with a small diverticulum. Spermiducal glands extend through segments XVII–XIX. Hab.—Zanzibar.

(8) Perionyx saltans, BOURNE.

P. saltans, BOURNE, P. Z. S., 1886, p. 669.

Definition. *Length, 60 mm.; diameter, 6 mm.; number of segments, 61. Clitellum, XIV–XVI. Setae, 45–54 per segment. Nephridia alternate in position. Spermathecae in VII, VIII, IX, each with two minute appendices. No modified setae. Hab.—Nilgiris, India, 7,500 feet.*

Although BOURNE'S description of this species is far from complete, there is no possibility of confounding it with any other species. The worm is said to have the same active habit as *Perichaeta*, whence its name.

Genus DIPOROCHAETA, BEDDARD.

Syn. **Perichaeta** (in part.), BEDDARD.

DEFINITION. **Clitellum generally more than three segments. Nephridia paired. Spermiducal glands tubular.**

This genus includes one species which is a native of New Zealand, and some of the species provisionally referred by FLETCHER and SPENCER to the genus *Perichaeta*, viz. *Perichaeta barronensis*, &c. A few species have a very limited number of setae on anterior segments.

(1) Diporochaeta intermedia (BEDDARD).

Perichaeta intermedia, BEDDARD, Q. J. M. S., vol. xxx, 1890, p. 467.

Definition. *Length, about 6 in.; a stout species. Colour during life a bluish green. Dorsal pores absent. Setae with slight dorsal and ventral gaps, about 75 on posterior segments. Between the male pores only a single seta on each side. Calciferous glands in X/XI. Septa, VIII/XV, thickened. Last heart in XII. Sperm-sacs in IX–XII. Spermathecae in V–VIII. Hab.—New Zealand.*

This species has a number of genital papillae in neighbourhood of the male pores. There are a pair upon the eighteenth segment, just in front of the male pores; another

pair occupy a corresponding position on the following segment; on xvii there are five papillae; and finally there are six on xx. The egg-sacs are large in xiv, racemose in form, and the ova which lie within them are covered with younger germinal cells.

(2) Diporochaeta barronensis, FLETCHER.

Perichaeta barronensis, FLETCHER, Proc. Linn. Soc., N. S. W. (2), i, 1886, p. 960.

Definition. *Length, 63 mm.; diameter, 4 mm.; number of segments, 125. Clitellum, XIV–XVII. Setae about 40 per segment, with prominent gaps. Dorsal pores begin IV/V. Gizzard in VII (?); no distinct calciferous glands; intestine begins in XVI. Last hearts in XIII. Sperm-sacs in X–XII; spermathecae in V–VII each with a diverticulum. Hab.—Barron river, N. Queensland.*

There are a few points about this species which require clearing up; the nephridia are stated to be paired; but it is, of course, possible that in addition to these there may be the small diffuse groups of tubes. The spermiducal glands are thus described by FLETCHER 'their proximal portion long, narrow, continuous with the genital ducts, looking more like convoluted thick walled tubes than solid glands, their distal portions a little more compact,' &c.; the question is, whether by this description FLETCHER intends to say that they are tubular as in *Diporochaeta*, or whether they are like the spermiducal glands of other *Megascolex*. There appear to be no genital papillae.

(3) Diporochaeta bakeri, FLETCHER.

Perichaeta Bakeri, FLETCHER, loc. cit. (2), ii, 1887, p. 616.

Definition. *Length, 92 mm.; diameter, 6 mm.; number of segments, 140. Colour (in spirit) a dark purplish. Prostomium completely divides buccal ring, marked above by a longitudinal groove. Setae stouter and longer in anterior segments, 22–36 per segment, with gaps. Clitellum, XIII–XVII. Oviducal pores paired. Dorsal pores commence IV/V. Genital papillae a pair on XVII/XVIII–XX/XXI. Gizzard in V; intestine begins in XVII. Last hearts in XII. Sperm-sacs in IX, XII; spermathecae in V–IX with a diverticulum. Penial setae present. Hab.—Gippsland, Victoria.*

This species also is, perhaps rightly, to be referred to *Megascolex*; it seems to have paired nephridia; but here, again, we may eventually learn that there are the minute tufts of tubules which characterize other *Megascolex*. The spermiducal glands are said by FLETCHER to be 'a long narrow body coiled into a compact mass.' This seems like a tubular gland; and if such really exists it will be

necessary either to include this species in my genus *Diporochaeta,* or to found a new genus for it.

(4) Diporochaeta terrae-reginae (Fletcher).

Perichaeta terrae-reginae, Fletcher, loc. cit. (2), iv, 1889, p. 1002.

Definition. *Length,* 190 *mm.; breadth,* 18 *mm.; number of segments,* 144. *Clitellum, XIII–XXII (?). Setae,* 40–60. *Dorsal pores commence V/VI. Nephridiopores forming a sinuous series. Hab.—Mount Bellenden-Ker, N. E. Queensland.*

The single specimen of this species examined by Fletcher was not dissected, hence its systematic position is a matter of doubt. He considers that it belongs to the same division as *Megascolex canaliculata.* This opinion may or may not be correct.

(5) Diporochaeta dicksonia (Spencer).

Perichaeta dicksonia, Spencer, P. Roy. Soc. Vict., 1892, p. 16.

Definition. *Length,* 50 *mm. Prostomium complete. Clitellum, XIV–XVI. Setae,* 20–22. *Genital papillae median XVII/XVIII, XVIII/XIX. Intestine begins in XVII. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in V–IX. Hab.—Fern Tree Gully, Victoria.*

(6) Diporochaeta alsophila (Spencer).

Perichaeta alsophila, Spencer, loc. cit., p. 17.

Definition. *Length,* 50 *mm.; number of segments,* 104. *Clitellum, XIV–XVI. Setae,* 20–26. *Genital papillae median on VII, VIII, XVII/XVIII, XVIII/XIX, paired on XVI/XVII. Oesophageal swellings in IX–XV; intestine begins in XVII. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in VI–IX. Hab.—Fern Tree Gully, Victoria.*

(7) Diporochaeta yarraensis (Spencer).

Perichaeta yarraensis, Spencer, loc. cit., p. 23.

Definition. *Length,* 140 *mm. Prostomium complete. Clitellum, XIII–XVII. Setae,* 8 *on first two segments,* 10 *up to clitellum, behind this* 20–28. *Genital papillae paired on XV/XVI–XXI/XXII. Oesophageal swellings in XIII–XV; intestine begins in XVII. Last heart in XII. Sperm-sacs in IX, XII, XIII. Spermathecae in V–IX. Penial setae present. Hab.—Tanjil Track, and Warragul.*

(8) Diporochaeta tanjilensis (SPENCER).

Perichaeta tanjilensis, SPENCER, loc. cit., p. 24.

Definition. *Length,* 90 *mm. Prostomium complete. Clitellum, XIV–XVII. Setae,* 8 *on first six segments, after gradually increasing to* 20. *Genital papillae paired on XVI–XXI between the segments. Other organs as in last species. Hab.—Gembrook, Warburton, Tanjil Track, Fern Tree Gully, Dandemong, Victoria.*

(9) Diporochaeta copelandi (SPENCER).

Perichaeta copelandi, SPENCER, loc. cit., p. 2.

Definition. *Length,* 125 *mm.; number of segments,* 175. *Prostomium complete. Clitellum, XIII–XVII. Setae,* 20–34 *in front of and on clitellum,* 46–50 *behind. Genital papillae paired on IX–XIII, paired on XVI/XVII–XIX/XX. Oesophageal swellings on IX–XV; intestine begins XVII. Last heart in XII. Sperm-sacs in IX, XII, XIII. Spermathecae in V–IX. Hab.—Warragul, Victoria.*

(10) Diporochaeta obscura (SPENCER).

Perichaeta obscura, SPENCER, loc. cit., p. 3.

Definition. *Length,* 70 *mm.; number of segments,* 100. *Prostomium complete. Clitellum, XIII–XVI. Setae,* 18–24. *Genital papillae paired on XVI/XVII, XVII/XVIII, to the inside a pair of XVIII, median on XVIII/XIX, XIX/XX. Oesophageal swellings in XII–XV; intestine begins in XVII. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in V–IX. Hab.—Warragul, Fern Tree Gully, Victoria.*

(11) Diporochaeta lochensis (SPENCER).

Perichaeta lochensis, SPENCER, loc. cit., p. 13.

Definition. *Length,* 75 *mm. Clitellum, XIII–XVI. Setae,* 18–20, *or even* 38. *Genital papillae paired XVIII/XIX, XIX/XX. Oesophageal swellings in XII–XV; intestine begins in XVII. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in V–IX. Hab.—Loch, S. Gippsland, Victoria.*

(12) Diporochaeta dubia (Spencer).

Perichaeta dubia, Spencer, loc. cit., p. 14.

Definition. *Length*, 45 *mm.; number of segments*, 100. *Prostomium complete. Clitellum, XIII–XVII. Setae*, 12–24. *Genital papillae paired XVII/XVIII–XIX/XX. Oesophageal swellings in IX–XIV. Intestine begins in XVIII. Last heart in XII. Sperm-sacs in IX, XII. Spermathecae in V–IX. Hab.—S. Warragul, Victoria.*

(13) Diporochaeta walhallae (Spencer).

Perichaeta walhallae, Spencer, loc. cit., p. 15.

Definition. *Length*, 25 *mm.; number of segments*, 88. *Clitellum XIV–XVI. Setae*, 20–24. *No genital papillae. Intestine begins in XV (?). Last heart in XII. Sperm-sacs in XII. Spermathecae in V–IX. Hab.—Walhalla, Victoria.*

Family CRYPTODRILIDAE.

Definition. **Terrestrial (sometimes aquatic) Oligochaeta, with eight setae per segment. Clitellum variable in extent, occupying some or all of segments XII–XXIII, usually complete anteriorly. Spermathecae, one to five pairs, placed anteriorly, nearly always with one or two diverticula. Male pores on segment XVII or XVIII, opening independently of, or into the distal non-glandular part of, the spermiducal gland, which is either tubular or lobate, always present. Penial setae generally present. Nephridia paired or diffuse.**

This family is the most extensive of any of the families of earthworms, excepting only the Lumbricidae and Perichaetidae, and embraces more generic types, many of which are, however, ill-defined. Previously to the last few years, when the only generic types known were *Digaster*, *Pontodrilus*, *Plutellus*, and *Typhaeus*, the family, as well as the genera were easy to be defined. The large number of new genera and species which have since been described, particularly by Fletcher and Spencer in Australia, make it a very difficult matter to separate the genera.

I have already given reasons for dividing Rosa's family 'Eudrilidae' into Cryptodrilidae and Eudrilidae.

The Cryptodrilidae includes the following genera:—

(1) **Digaster**, PERRIER.
(2) **Pontodrilus**, PERRIER.
(3) **Plutellus**, PERRIER.
(4) **Typhaeus**, BEDDARD.
(5) **Megascolides**, McCOY (= **Notoscolex**, FLETCHER).
(6) **Cryptodrilus**, FLETCHER.
(7) **Dichogaster**, BEDDARD.
(8) **Deodrilus**, BEDDARD.
(9) **Microscolex**, ROSA.
(10) **Nannodrilus**, BEDDARD.
(11) **Ocnerodrilus**, EISEN.
(12) **Gordiodrilus**, BEDDARD.
(13) **Microdrilus**, BEDDARD.
(14) **Fletcherodrilus**, MICHAELSEN.
(15) **Trinephrus**, BEDDARD.
(16) **Millsonia**, BEDDARD.

This list includes all the genera which are accepted in the present work. A few other names have been given, i.e. *Notoscolex*, *Didymogaster*, *Deltania*, *Perissogaster*, *Argilophilus*, *Rhododrilus*, and *Photodrilus*, which I regard as synonymous with some one or other of the above.

The Cryptodrilidae are, like many other families of terrestrial Oligochaeta, of various sizes; at the one end of the series we have the 'Giant earthworm of Gippsland,' which is one of the largest of its kind; at the other extreme there are the tiny species of *Gordiodrilus* and of the genera *Microdrilus* and *Microscolex*.

With the exception only of the genus *Deodrilus*, all the Cryptodrilidae have a *prostomium*; in no Cryptodrilid are there more than eight *setae* in each segment; these setae may be strictly paired, or they may be in many species, disposed in eight equidistant lines; SPENCER (2) has described an irregular arrangement of the setae in certain Australian members of the genera *Cryptodrilus* and *Megascolides*, limited to the posterior segments of the body. In two genera only have ornamented setae so characteristic of the family Geoscolicidae been met with; I described in *Deodrilus jacksoni* setae of this kind, and, more recently, MICHAELSEN has found ornamented setae in *Pontodrilus bermudensis*. The setae of *Deodrilus* are defective upon the first five segments of the body; this peculiarity, so common among the Geoscolicidae, is not, to my knowledge, found elsewhere among the Cryptodrilidae (unless possibly in *Millsonia*). Nor do we meet with any special modification of the clitellar setae such as is even more common among the members of the last-named family. The setae are, as in many other worms, occasionally defective upon the segment which bears the male pores; this is the case, for example, with *Dichogaster*, where the ventral setae of the seventeenth segment are totally absent.

Dorsal pores are present or absent. The *clitellum* is of variable extent; it does not commence before the twelfth segment, and may extend back as far as the twenty-second; no Cryptodrilid has a clitellum consisting of fewer than three segments and

four or five is the usual number. Papillae are constantly met with in the neighbourhood of the male genital pores.

As regards internal structure, there is a tolerable uniformity, less marked, it is true, than in the Lumbricidae, but more marked than in the Geoscolicidae or Eudrilidae. Neither the *alimentary tract* nor the *vascular system* call for any particular comment; they are both much as in the Perichaetidae, though the caeca, so characteristic of that family, are only met with in the genus *Millsonia*. The *nephridia* are found in three chief variations; the most common, perhaps, is the diffuse form of the excretory organs limited to this family, to the Acanthodrilidae, and to the Perichaetidae; in a large number of other species there are regularly paired nephridia, which may, even in a few species, show an alternation, as in certain Acanthodrilidae; *Plutellus* has nephridia of this kind and also *Cryptodrilus fletcheri;* the third form in which the nephridia are developed is very remarkable; in a few species referred by me to the genus *Trinephrus* there are three distinct pairs of these organs. The *male ducts* invariably open on to the exterior in common with, or in the immediate neighbourhood of, *spermiducal glands*, *penial setae* being very frequently present; the spermiducal glands are, as in the Perichaetidae, of two kinds; there are either the lobate glands of *Cryptodrilus* or the tubular glands of *Megascolides;* in *Trinephrus fastigatus* there are two pairs of these glands, and in *Dichogaster damonis* the single pair which are connected with the male ducts are followed by two other pairs in as many consecutive segments. The *spermathecae* of this family are nearly always furnished with diverticula; it is only in some of the small and degenerate (?) types that diverticula are absent; the spermathecae are paired structures (except in *Fletcherodrilus*, where they are in a single median series), and the number of pairs varies from one to five; they lie anteriorly to the testes.

The headquarters of the Cryptodrilidae is, perhaps, the Australian continent; a large number of species have been described from that country by FLETCHER and SPENCER. These belong to the genera *Megascolides* (=*Notoscolex*), *Cryptodrilus*, *Fletcherodrilus*, *Trinephrus*, and *Digaster*, all of which genera are nearly confined to that part of the world.

The two first named are not at all easy to distinguish from each other. '*Notoscolex*' was thus defined by FLETCHER (**1**, p. 546):—

'Intraclitellian worms with clitellum, comprising some or all of the segments xiii–xxiii; male pores two, on segment xviii, on papillae in a line with the intervals between the inner couples of setae; oviducal pores on segment xiv; setae in eight longitudinal rows.'

Later in the paper, which contains the definition of *Notoscolex* (on p. 570), *Cryptodrilus* is thus defined, though in a more informal fashion: 'postclitellian, has eight rows of setae arranged in a peculiar manner, has three or four pairs of accessory gland-pores, two pairs in front of, and the others behind, the male pores which are on segment xviii, and one gizzard.'

In a later paper, FLETCHER (**4**, p. 614) came to the conclusion that the differences between these two genera were not as originally stated; he says: 'Hence it seems to me that the chief difference between the genera *Notoscolex* and *Cryptodrilus* is becoming narrowed down to the question of segment xviii being included in the girdle. I begin to suspect, therefore, that when I come to revise the species already described, with additional material to work upon, it may be necessary to include the latter in the former genus, or, at any rate, to regard it as a subgenus.'

The difficulty of distinguishing these two genera was still further commented upon by FLETCHER in the following year (1888). He writes as follows: 'They include . . eleven species of *Cryptodrilus*, which, with four already described, make a rather heterogeneous collection of postclitellian worms (with four couples of setae to a segment, male pores on xviii, a single gizzard, and, in such cases as they have been visible, a single pair of vasa deferentia), among which it is possible to pick out a well-marked group of which *C. mediterreus* may be taken as the type, and a second smaller group of the type of *C. saccarius;* the remainder differ among themselves, and from these so much as not at present to permit of their being satisfactorily sorted into sections. As every considerable acquisition of new material throws fresh light on this matter, it would be premature just now to attempt to separate any of them as types of new genera. Nevertheless, worthy of mention are *C. fastigatus*, with three pairs of nephridio-pores to a segment, and two pairs of prostates, the two prostatic ducts of each side uniting to form a single genital duct; *C. unicus* with a single median series of spermathecal and male pores—an intermediate condition between this and the rather widely separated pores in forms like *C. sloanei* being offered in *C. manifestus;* and *C. singularis* with but single pairs of testes, ciliated rosettes, and vesiculae—a condition which obtains also in *Megascolides* (*Notoscolex*) *illawarrae:* . . . characters other than those of the clitellum, which will satisfactorily separate forms like *Megascolides* (*Notoscolex*) and *Cryptodrilus*, are still desiderata.'

I shall attempt to divide up the large number of species which have been referred to these two genera in any way which appears to me to recognize the principal structural differences.

The three most salient points of difference, as it appears to me, between the

various species which make up these two genera are: (1) the meganephric or plectonephric condition; (2) the tubular or lobate character of the spermiducal glands; and (3) the presence or absence of penial setae.

Only four species, viz. *M. tuberculatus*, *M. illawarrae*, *C. mediterreus*, and *C. rubens*, have penial setae. They do not, however, show any other marked characters in common which would justify their separation and inclusion in a distinct genus. Accordingly, I prefer to pass on to the other characters.

Spencer (2) does not make use of these particular characters in separating the genera; we find, for example, that '*Megascolides*' contains species with tubular and lobate spermiducal glands; the same genus also contains species with a plectonephric and with a meganephric excretory system; on the other hand, all his species of *Cryptodrilus* have tubular spermiducal glands and paired nephridia, with the sole exception of *C. dubius*, where there are three pairs of nephridia to each segment—possibly hardly to be regarded as an exception, as it has not, at any rate, the truly diffuse nephridia. It will be further noted from the accurate and highly useful details given by Spencer that in these worms the last pair of hearts are in the twelfth segment. In *all* the species of worms described by Spencer in the paper just referred to we find that paired nephridia are associated with the existence of the last pair of hearts in the twelfth segment. Whereas in those species which have a diffuse excretory system the last pair of hearts are in the next, i. e. the thirteenth segment. Moreover, these species which are characterized by the two points referred to, have nearly always lobate spermiducal glands; there are exceptions to this statement, however; for example, *M. australis*, *M. incertus*, *M. gippslandicus* (? as to its real distinctness from one or other of the above) have a diffuse nephridial system with tubular glands. Out of the twenty-one species of *Megascolides* and *Cryptodrilus*, with whose anatomy Spencer has made us acquainted, sixteen conform to the association of characters just mentioned: they have either (1) paired nephridia, tubular spermiducal glands, last pair of hearts in the twelfth segment; or (2) diffuse nephridia, lobate glands, last hearts in the thirteenth segment. There are three exceptions to this rule; these are *C. intermedius*, *M. sinuosus*; in the former of the two paired nephridia are associated with tubular glands, but the last pair of hearts are in the thirteenth segment; in the latter diffuse nephridia are associated with the last pair of hearts in the thirteenth segment, but the spermiducal glands are tubular.

In the following table the chief structural features of most of the species placed in the above two genera are set forth.

	PROSTOMIUM.	CLITELLUM.	SETAE.	GIZZARD.	CALCIFEROUS GLANDS.	♂ GONADS.
M. camdenensis	incomplete	xiv–xxiii	8 rows	vi	xiv–xvi	double
M. grandis	,,	xiii–xix	,,		o	,,
C. rusticus	,,	xiii–xvii	,,	v	o	,,
M. gippslandicus	,,	xiii–xxi	4-3>2-1	v	o	,,
M. tasmanianus	,,	xiii–xxii	8 rows	v	o	,,
M. tuberculatus	,,	xiii–xviii	,,	v	o	,,
C. mediterreus	,,	xiii–xvii	,,	v	x–xiii	,,
C. rubens	,,	xiv–xvi	,,	absent	x–xiii	,,
C. saccarius	,,	xiii–xvii	4-3>2-1	v or vi	ix–xiii	,,
M. illawarrae	,,	xiii–xxii	8 rows	?	o	single
M. pygmaeus	,,	xiv–xix	4-3>2-1	?	xii, xiii	double
C. mudgeanus	,,	xiii–xviii	,,	v	x–xiii	,,
C. canaliculatus	,,	xiii–xviii	8 rows	v	x–xiii	,,
C. sloanei	,,	?			xi–xiii	
C. oxleyensis	,,				xi–xiii	
C. manifestus	complete	xiv–xvii	,,	v	x–xiii	double
C. unicus	incomplete	xiv–xvii	,,	v or vi	xiii–xv	,,
C. fastigatus	complete	xiv–xvii	4-3>2-1	v		,,
C. tenuis	,,	?	,,			
C. mediocris	incomplete	xiii–xvii	,,	v		,,
C. illawarrae	,,	xiv–xvii	,,	v	o	,,
C. singularis	,,	xiii–xviii	paired	vi	o	single
C. gippslandicus	complete	xiii–xvii	paired; irregular behind	v	xiv, xv	double
C. intermedius	incomplete	xiv–xviii	paired	v	o	single
C. tanjilensis	complete	xiii–xvii	4-3>2-1	v	o	double
C. frenchi	incomplete	xiv–xvi	,, irregular	vi	o	,,
C. dubius	complete	xiv–xvii	4-3>2-1	v	xv, xvi	,,
C. macedonensis	incomplete	?	,,	v	o	,,
C. victoriae	complete	xiv–xvi	,,	v	o	,,
C. willsiensis	incomplete	xiv–xvii	,,	v	o	,,
C. narrensis	,,	xiii–xviii	,,	v	o	,,
C. lucasi	,,	xiii–xviii	,,	v	o	,,
C. minor	,,			v	o	single
M. cameroni	,,			v/vi		double
M. insignis	,,	xiii–xviii	,,	vi	xv, xvii	single
M. hulmei	,,	xiii–xx	,,	v		,,
M. obscurus	,,	xiii–xix	,,	vi	o	double
M. manni	,,	xiv–xviii	,,	v/vi	o	,,
M. victoriensis	,,		,, irregular	v	o	,,
M. incertus	complete	xiii–xviii	,,	vi	o	,,
M. sinuosus	incomplete		,,	v	o	,,
M. roseus	complete	xiii–xviii	,,	v	xv, xvi	,,
M. attenuatus	incomplete	xiii–xviii	,,	v	o	,,
C. simulans	,,		,,	v	xiv, xv	,,
C. semictus	,,	xiii–xvii	8 rows	v	ix–xiii	single
C. insularis	incomplete	?	,,	o	?	double

SPERMIDUCAL GLANDS.	PENIAL SETAE.	SPERMATHECAE.	LAST HEART.	NEPHRIDIA.	DORSAL PORES.
lobate	o	viii, ix ; one small div.	xiii	diffuse	+
,,	o	,, ,,	,,	,,	+
,,	? o	viii, ix ; two or three div.	xii	,,	+
tubular	o	viii, ix ; notched div.	xiii	,,	+
,,	o	v–ix ; *no* div.	,,	paired	+
,,	+	viii–ix ; div.	xii	,,	+
lobate	+	vii–ix ; div.	xiii	,, (alt.)	+
tubular	+	?	xii	paired	o
?	?	viii–ix ; div.	xiii	diffuse	+
?	+	,,	xii	diffuse + paired	+
?	?	,,	,,	diffuse	+
?	o	,,	xiii	,,	+
?	?	vii–ix ; two div.		paired (alt.)	+
		three pairs	,,		
		vi–ix ; div.			+
?		,,	xii	,,	+
?		v–ix ; div.	,,	paired	+
two pairs		viii, ix ; div.	xii or xiii	three pairs	+
tubular		two pairs		,,	?
lobate		viii, ix ; div.	xii	,,	+
	o	viii, ix ; two div.	,,	diffuse	+
		viii, ix ; div.	,,	,,	+
tubular		v–ix ; div.	,,	paired	+
tubular	o	viii, ix ; one div.	xiii	,,	+
,,	o	v–ix ; one div.	xii	,,	?
,,	o	v–ix	,,	,,	+
,, (double)		viii, ix ; two div.		three pairs	+
tubular		vi–ix ; one div.		paired	+
,,		v–ix ; one div.	,,	,,	+
?		v–ix ; two div.	,,	,,	
tubular		viii, ix ; div.	,,	,,	
,,		,,	,,	,,	+
,,		,,	,,	,,	+
lobate		v–ix ; div.	xiii	diffuse	+
,,		viii, ix ; div.	,,	,,	+
,,		,,	,,	,,	+
,,		viii, ix	,,	,,	+
tubular		vii, ix	xii	paired	+
lobate		viii, ix	xiii	diffuse	+
tubular		,,	xii	paired	
,,		,,	xiii	diffuse	
,,		,,	xii	paired	+
,,		,,	,,	,,	+
?	+	,,	,,	diffuse	+
tubular		,,	,,	paired	? +
,,	o	viii, ix ; without div.		commence in xiii	

A careful tabulation of FLETCHER'S results (from above table) does not perhaps altogether support this proposed division of the genera; but in only a few cases has he noted the form of the spermiducal glands, which is, I believe, of systematic importance. Out of the twenty-three species to which he has paid attention, five conform to the rule of association which I have endeavoured to lay down above; four are apparently exceptions; of these four *C. rusticus* has diffuse nephridia, lobate glands, but the last pair of hearts are in xii; I have already referred to *M. gippslandicus* as another exception resembling *M. australis; M. tasmanianus* has paired nephridia and tubular glands, but the last pair of hearts are in xiii; *C. mediterreus* has paired nephridia with lobate glands, the last pair of hearts in xiii; of the remaining species, three are peculiar in having three pairs of nephridia per segment like one of the species described by SPENCER; so I put them out of the comparison, reserving a distinct generic title for them. There remain eleven species which are not sufficiently described by FLETCHER; in nine of them the condition of the nephridia and the segment occupied by the last pair of hearts is noted; five of these agree with the proposed division; *C. fletcheri*, described by myself, has paired nephridia with lobate spermiducal glands. On the whole, therefore, it seems to me to be justifiable to retain the two generic names *Cryptodrilus* and *Megascolides*, but to sort the species rather differently. I put those with tubular glands on one side, reserving the name *Megascolides* for them; the species with lobate glands I call *Cryptodrilus.*

In addition to these there remain a number of Australian species which FLETCHER has relegated to three genera—*Digaster, Perissogaster,* and *Didymogaster;* the name of the latter must in any case, as FLETCHER has pointed out, be dropped since it has been already applied to a genus of insects. These three genera contain between them only seven species; in the following table the chief characters of these seven species are set forth.

	PROSTOMIUM.	CLITELLUM.	SETAE.	GIZZARD.	CALCIFEROUS GLANDS.	PEPTO-NEPHRIDIA.
Digaster armifera	incomplete	xiii–xviii	paired, ventral closer	2 in v, vi	o	+
Perissogaster nemoralis	,,	xiii–xviii	,, ,,	3 in v–vii	x–xiv	+
Perissogaster queenslandica	,,	?	,, ,,	,,	xiv, xv	
Digaster perrieri	,,	xiv–xvii	,, ,,	2 in v, vi	o	+
Digaster lumbricoides		xiv–xvi	paired			
Perissogaster excavata	,,	xiii–xviii	paired, ventral closer	3 in v–vii	o	?
Didymogaster sylvaticus	,,	xiii–xviii	,, ,,	2 in vi, vii	o	

It will be noted from the above table that all these species agree in a number of important characters; they have all lobate spermiducal glands, diffuse nephridia, more than one gizzard, a clitellum of about the same extent, and two pairs of spermathecae; *D. sylvaticus*, and *Perissogaster* are peculiar in the spiral intestine; as, however, this peculiarity also occurs in *Plagiochaeta*, it is perhaps to be regarded as of less weight for systematic purposes in the present group. Penial setae are either present or absent; but their presence or absence does not appear to coincide with other differences. Considering that all these species are confined to Australia, it seems hardly necessary to separate them, as FLETCHER has done, into so many as three genera. I may be blamed for allowing them collectively generic distinction from *Cryptodrilus*, with which they agree in the lobate spermiducal glands and diffuse nephridia; as it is, I propose to place them all in one genus, which will, therefore, retain the name of *Digaster*. This genus will be distinguished from *Cryptodrilus* by the presence of two or three gizzards; this is the only positive difference.

MICHAELSEN (**13**, iv) has proposed to create a genus *Fletcherodrilus* for FLETCHER'S *C. unicus;* in the same species he places FLETCHER'S *C. fasciatus,* and his own *C. purpureus*, and *C. pelewensis*, considering them to be nothing more than varieties. The 'genus' is thus defined by MICHAELSEN:—'Borsten in 8 weit getrennten Reihen; Öffnung der Prostatadrüsen (auf dem 18. Segment gelegen) median und unpaarig; ebenso die Öffnungen der Samentaschen; Gürtel nicht über die Öffnung der Prostatadrüsen nach hinten hinausragend, ringförmig geschlossen; Darm mit einem einzigen Muskelmagen vor und mit Kalkdrüsen hinter den Hodensegmenten; je ein Paar grosser Segmentalorgane in den einzelnen Segmenten (ausmündend in den Borstenlinien iv); Lagerung der Geschlechtsorgane normal; ein Paar schlauchförmiger Prostatadrüsen (im 18. Segment); Penialborsten nicht vorhanden.'

SPERM-SACS.	SPERMIDUCAL GLANDS.	PENIAL SETAE.	SPERMATHECAE.	DORSAL PORES.	LAST HEART.	NEPHRIDIA.	HABITAT.
ix, xii	lobate	+	viii, ix	from xii/xiv	xii	diffuse	Australia
ix, xi, xii	"	+	"	from x/xi	xiii	"	"
xi, xiii [?]	"	o	"	from iii/iv	xii	"	"
xi, xii	"	+	"	from x/xi		"	"
	"	o [?]		from iv/v		"	"
ix, xii	"	?	"	none, or only at posterior end of body.	xii	"	"
ix, xii	"	?	vii–ix	from v/vi		"	"

The principal characteristic of the genus is, of course, the fusion into a single median series of the spermathecae.

About the same time I had myself suggested the desirability of separating MICHAELSEN'S *C. purpureus* into a distinct genus.

Previously to both of us FLETCHER had also surmised that it might ultimately be necessary to take this step. 'These three species,' he remarks, 'form a group of closely allied forms whose claims to be regarded as worthy of generic separation will be considered hereafter.'

I shall here adopt the generic name of *Fletcherodrilus* for the species of *Cryptodrilus* with median spermathecae and male pore.

There can be no doubt, I think, of the validity of my genus *Millsonia*, from Western Tropical Africa, unless indeed it should include the African *Dichogaster*.

Another genus of which the exact position is perhaps a matter of doubt is *Plutellus;* this was originally described by PERRIER twenty years ago. More recently BENHAM has met with what he believes to be a second species of the genus, and has suggested that there may be some errors in PERRIER'S account of *Plutellus heteroporus;* there is no doubt that if PERRIER'S description is accurate in every particular the species named by him *P. heteroporus* is not congeneric with BENHAM'S *P. perrieri;* accepting BENHAM'S corrections as probable, it is not an easy matter to distinguish *Plutellus* from *Megascolides*.

I abstract from BENHAM'S list of the chief characters of the genus the following:—

(1) Setae in eight rows.
(2) Clitellum complete, xiii–xviii.
(3) Male pores on xviii.
(4) Nephridiopores alternate.
(5) Testes in x; sperm-sacs in xi; spermiducal glands tubular.
(6) Spermathecae, four pairs without diverticulum.
(7) No calciferous glands.

P. heteroporus differs in (6) and (7); there are three pairs of calciferous glands, and the spermathecae have a diverticulum.

The above enumeration of the chief characters of *Plutellus* does not permit of a very distinct separation from *Megascolides*. Indeed, there is no character that is quite decisive in the matter. I do not, therefore, see my way to accepting the genus *Plutellus* at all, that is to say as amended by BENHAM; it may be that PERRIER'S original description may prove to be more accurate than it has been supposed to be; in this case the genus *Plutellus* will stand.

I shall now consider a group of Cryptodrilidae which have been referred to four distinct genera, and which should, as I think, be included in one group; I refer to *Ocnerodrilus* (including *Pygmaeodrilus*), *Nannodrilus*, and *Gordiodrilus*. These genera agree with each other, and differ from most earthworms (I shall mention an exception presently) in the following characters:—

(1) The calciferous glands, paired or single, lie in the ninth segment.

(2) The spermiducal glands are lined by a single layer of cells only.

Besides these points of resemblance, there are other agreements in various characters, which, though not unknown in other worms, mean something, perhaps, collectively. Such are:—

Absence of penial setae; small size; commencement of intestine in twelfth or fourteenth segment; absence of typhlosole; paired nephridia; last pair of hearts in eleventh segment; setae strictly paired.

Even if we take the most characteristic form, and one only of each of these genera, it is difficult to show contrasts that would be regarded as sufficiently marked to permit of so wide a separation as Eisen (**1, 4**) would institute, except perhaps in the case of *Gordiodrilus tenuis*, of which more presently.

For instance, let us compare *Gordiodrilus elegans*, *Ocnerodrilus eiseni*, and *Nannodrilus africanus*.

	CALCIFEROUS GLANDS.	SPERMIDUCAL GLANDS.	SPERMATHECAE.	SPERM-DUCT.
Gordiodrilus . .	unpaired	two pairs	two pairs; rudimentary diverticula	opens separately
Ocnerodrilus .	paired	one pair	one pair; no diverticula	opens with spermiducal gland
Nannodrilus . .	unpaired	two pairs	one pair; no diverticula	opens with one spermiducal gland into bursa copulatrix

Slender though these differences are, yet they must be held to be of sufficient importance to allow of generic separation. Too much stress cannot be laid upon the presence or absence of diverticula to the spermathecae. Although, among earthworms, diverticula are very constantly either present or absent in a family, let alone a genus, there are several instances where a genus has or has not, according to the species, diverticula appended to the spermathecae. But, nevertheless, we cannot but allow that *G. matthewsi* and *G. elegans* belong to the same genus, though one (*G. elegans*) has not, and the other has, at least traces of a pair of diverticula appended

to the spermathecae. Again, the presence of two pairs of spermiducal glands, so characteristic of *Gordiodrilus*, is not universal in that genus; for *G. ditheca*, in other respects extremely near to *G. elegans*, has but one pair of these structures; and, as I point out elsewhere (below), there are no reasons for regarding this species as having been described from individuals that were, in this particular, immature. The median unpaired calciferous gland of the typical *Gordiodrilus* is distinctly paired in *G. robustus;* nor is it permissible to found generic distinctions upon the paired or unpaired condition of an organ which a more profound study of the Oligochaeta shows to be an impossibility. The fact that in all the species of *Gordiodrilus* the sperm-ducts open quite independently of the spermiducal glands would be a slender basis for distinguishing two genera; and, moreover, we are relieved from all temptation to lay stress upon this character by the existence of different species of *Ocnerodrilus* in which the sperm-ducts are, and are not, separate up to their very opening from the spermiducal glands. But, in spite of these undoubtedly close resemblances, I prefer to keep the genera separate, on account of the different segment on which the sperm-duct opens, and its distinctness from the spermiducal gland.

There is a question whether *G. tenuis* is really congeneric with the other forms; unfortunately I was not able to give anything like a complete account of the anatomy of this species (**29**). In the meantime its differences from the other worms are not insignificant. In the first place the transference of the male genital pores so far back is a not unimportant character; it is true that such a variation in the position of these pores is found in species undoubtedly belonging to the same genus; *Buchholzia* is an instance to the point; but with the present worm there are other differences; the testes are but a single pair, and the enlarged ventral setae are another peculiarity; so also is the great extent of the clitellum.

The presence of calciferous glands in the ninth segment, and the structure of the spermiducal glands is not absolutely distinctive of the genera *Gordiodrilus*, *Nannodrilus*, and *Ocnerodrilus;* the family Acanthodrilidae contains a genus, *Kerria*, represented by two species, which shows a perfectly similar character; the calciferous glands are in the ninth segment, and the spermiducal glands are lined by a single layer of epithelium. In possessing no penial setae this genus differs from the vast majority of Acanthodrilidae; but this is not unknown in the family, for in the genera *Benhamia*, and *Acanthodrilus*, there are species without penial setae. In spite of the resemblances between *Ocnerodrilus* and *Kerria*, I think that it is necessary, in the present state of our knowledge, to place them in different families, though the existence of these forms shows how difficult it is to distinguish the two families, Cryptodrilidae and Acanthodrilidae; at present the Acanthodrilidae differ from all

Cryptodrilidae, including the two genera here treated of, in the fact that the two pairs of spermiducal glands lie not in successive segments, but are separated by a segment which bears the apertures of the sperm-ducts. It is very possible, however, that this genus, *Kerria*, is a stage in the development of the genus *Ocnerodrilus* out of *Acanthodrilus*, or it may be that the resemblance is due to a convergence caused by a simplification in structure; in this case it might be said that the likeness between *Ocnerodrilus* and *Gordiodrilus* is something of the same kind; but here the resemblance is rather closer; indeed, the only difference between the two genera is that the structure of the calciferous glands is a little different, and that the male pore opens upon a different segment, independently also of spermiducal glands.

Besides the genera just referred to which appear to be simpler in structure than the more typical forms, there are three other genera not nearly related to those just described, but also showing some evidence of degeneration; these are *Pontodrilus*, *Photodrilus*, and *Microscolex;* the latter, however, is not quite so simplified as are the first two genera.

They are all three of small size; there is often no gizzard, or merely traces of a gizzard; there are sometimes no dorsal pores; the nephridia do not commence until the fourteenth or the fifteenth segment, except in *Microscolex*, where they begin earlier, and they are paired structures; the subnervian vessel is absent; there is no typhlosole.

In these particulars the three genera appear to be somewhat degenerate as compared with other Cryptodrilidae, though not so much so as are the genera *Gordiodrilus* and *Ocnerodrilus;* in this case, as in that, smallness of size accompanies simplification of structure.

The following table indicates the mutual relationships of the three :—

	MICROSCOLEX.	PONTODRILUS.	PHOTODRILUS.
Setae	in eight rows, or paired	in eight rows	in eight rows
Male pores	xvii	xviii	xviii
Nephridia	begin in ii–v	begin in xv	begin in xiv
Gizzard	present, rudimentary, or absent	rudimentary	absent
Calciferous glands . .	absent	absent	,,
Last heart . . .	in xii	in xiii	in xii
Spermathecae . .	one pair	two pairs	one pair
Spermiducal glands .	tubular	tubular	tubular

It will be obvious from the above table that *Photodrilus* and *Pontodrilus* are nearer to each other than either of them is to *Microscolex*. So near does this resemblance appear to me to be, that I think it is desirable to unite the two genera into one, which must obviously bear the name of *Pontodrilus*. The only point of importance which divides this genus from *Microscolex* is the position in the latter of the male pores upon the seventeenth instead of the eighteenth segment. The nearly invariable presence in *Microscolex* of penial setae distinguishes it from the two remaining forms, which I unite here into a single genus.

In the following table the principal characters of the genera of Cryptodrilidae are placed side by side for comparison:—

	NEPHRIDIA.	GIZZARD.	LAST HEART.	CALCIFEROUS GLANDS.	MALE PORE.	SPERMIDUCAL GLANDS.	PENIAL SETAE.	HABITAT.
Gordiodrilus .	paired	+ or o	xi	ix	xviii or xx	xvii–xix, tubular	o	Africa ; W. Indies
Ocnerodrilus .	,,	o	xi	ix	xvii	xvii, tubular	o	America and Africa
Nannodrilus .	,,	rudimentary	xi	ix	xviii	xvii, xviii, tubular	o	Africa
Microscolex .	,,	+ or o, or rudimentary	xii	o	xvii	xvii, tubular	present (rarely o)	Europe ; America ; New Zealand ; Teneriffe
Pontodrilus .	,,	rudimentary	xii	o	xviii	xviii, tubular	o	Europe ; W. Indies; E. Indies
Typhaeus . .	diffuse	+	xiii	xii or xiii	xvii	xvii, tubular	present	India
Dichogaster .	,,	2	?	xiv (xv)–xvi (xvii)	xvii	xvii, tubular	present or o	Africa ; Fiji
Deodrilus . .	,,	+	?	xv–xvii	xviii	xviii, lobate	+	Ceylon
Fletcherodrilus	paired	+	xii	xiii–xv	xviii	xviii, tubular	o	Australia
Trinephrus .	three pairs	+	xii	x (xi)–xiii	xviii	xviii, lobate or tubular	+ or o	,,
Digaster . .	diffuse	2 or 3	xii or xiii	x–xiv or xiv, xv	xviii	xviii, lobate	+ or o	,,
Megascolides .	diffuse or paired	+	xii or xiii	x–xiii or more	xviii	xviii, tubular	o	Australia, New Zealand, America
Cryptodrilus .	diffuse or paired	+	xii or xiii	x–xiii or xiv–xvi, &c.	xviii	xviii, lobate	+ or o	Australia
Microdrilus .	diffuse	2		xv–xvii	xvii	xvii, tubular	+	Java, Penang
Millsonia . .	,,	2	xiii	xv-xviii	xvii (paired or single)	xvii, tubular	o	W. Africa

Affinities of Cryptodrilidae.

This family has perhaps the most intimate relations[1] with the Perichaetidae; the genus *Megascolex* forms an almost ideal link; the fact that in the Perichaetidae there are invariably more than eight setae per segment, is really the only distinguishing mark which enable them to be differentiated from the Cryptodrilidae; and it will be remembered that in the genus *Megascolex* the anterior segments may have only eight setae apiece, while further back the setae become numerous. This genus might with equal reason be assigned to either of the two families Perichaetidae or Cryptodrilidae. It is not too much to say that there is hardly a single point of structure in the Cryptodrilidae which is not also characteristic of the Perichaetidae, and *vice versa,* that is to say of some one or more Perichaetous worms or Cryptodrilids. At first sight there may be some objection to this statement. Many Cryptodrilids have two gizzards, or even three; while, with the exception of *Pleionogaster*, no *Perichaeta* (in the wide sense) has more than a single gizzard; and the gizzards of *Pleionogaster* being at the posterior end of the oesophagus rather recall the similarly placed gizzards of the Eudrilids, *Hyperiodrilus* and *Heliodrilus*, than *Dichogaster* or *Digaster*. The genus *Perichaeta*, however (in the strict sense), has a gizzard which occupies certainly two, if not three segments; where there are two gizzards in the Cryptodrilidae they lie in consecutive segments; now there is not a wide interval between the two kinds of modification; and I should be disposed to compare the single gizzard of *Perichaeta* occupying two to two separate gizzards in a Cryptodrild occupying two consecutive segments, rather than to compare it with the single gizzard of such a form as *Eudrilus* or *Acanthodrilus*.

With other families of Oligochaeta there are not such plain relationships. The Acanthodrilidae, for example, are separated by certain well-marked characters from all Cryptodrilidae.

Michaelsen (10) has certainly compared *Dichogaster* with *Benhamia*, giving a tabular statement of the points of similarity and difference; although these resemblances are undoubtedly numerous and striking, there is one difference which absolutely distinguishes all Cryptodrilidae from all Acanthodrilids; in every Acanthodrilid the male pores open on to the eighteenth segment; and the spermiducal

[1] The intimate relationship which exists between all the families of the Megascolicidae is, perhaps, exemplified by the genus *Microscolex* of S. America and its affinities to the *Acanthodrilus* of that continent, and by the Cryptodrilids and Perichaetids of Australia. The sperm-sacs of the American *Microscolex* and *Acanthodrilus* are frequently in segments ix, xi, or in xi only—an unusual position. Those of the Australian worms are often in segments ix, xii, also an unusual position.

glands open on to the segment in front of and the segment behind this, or if there is but one pair, as in the species *Acanthodrilus monocystis* alone, they open on to the seventeenth segment; in the Cryptodrilidae, on the other hand, the termination of the sperm-ducts may be independent of that of the spermiducal glands, but if this is the case the two pores are nearly always situated upon the same segment[1]. *Gordiodrilus* does not form an exception to this statement; it is true that here the sperm-duct-pore is independent of that of the spermiducal glands of which there are two pairs opening on to consecutive segments; but one of these opens on to the same segment as that which bears the sperm-duct-pores, whereas in *Acanthodrilus* the sperm-duct-pore is *never* upon the same segment as that of the spermiducal glands. Apart, however, from this difference it would be difficult to draw a sharp line of demarcation between the Cryptodrilidae and the Acanthodrilidae. There are no other structural peculiarities in which either family is totally differentiated from the other. I am disposed to agree with MICHAELSEN in considering that *Dichogaster* is one of the genera which is nearest akin to the genus *Benhamia*. It will be remembered that in the type-species of the former genus—*Dichogaster damonis*—there are three pairs of tubular glands of which the two posterior opening on to the eighteenth and nineteenth segments are the smaller, and the anterior pair in common with which open the sperm-ducts are distinctly the larger; if we suppose the middle pair of these to disappear, and the sperm-ducts to be continued on to the eighteenth segment we should have an Acanthodrilid at once.

Another point of resemblance to the Acanthodrilidae is to be seen in *Microdrilus saliens* and in *Ocnerodrilus;* in the former worm the buccal cavity has, as I have mentioned in my account of the anatomy of this species, a diverticulum, which is of a different structure to the alimentary tract of which it is a diverticulum; the cells are more glandular and stain but feebly in carmine; MICHAELSEN, HORST, and I myself have described in various species of *Benhamia* a perfectly similar diverticulum; the description which HORST has given of this diverticulum of the buccal cavity in the species *Benhamia malayana* (**17**, p. 36), which I have already referred to in considering the anatomy of the alimentary canal in the Oligochaeta, shows its identity with that which I have seen in *M. saliens;* as a matter of fact, however, I have had the opportunity of comparing the structure in question for myself in *B. crassa*, and can, therefore, certify to its exact similarity; in both *Microdrilus*, and in, at any rate, one species of *Benhamia:* i.e. that which has only just been mentioned, the end of the sperm-duct, near to its external pore, is enveloped in a thick layer of muscular fibres; the same thing

[1] *Microscolex modestus* is an exception.

occurs in three or four species of the *Ocnerodrilus*. *Microdrilus* shows further resemblances to *Benhamia* in having two gizzards in immediately consecutive segments, and three pair of calciferous glands which seem to occupy the very same segments as in *Benhamia;* so also do those of *Millsonia*, the penial setae are practically indistinguishable from those of *B. crassa;* indeed, *M. saliens* only differs from that species of *Benhamia*, in the fact, that there is but a single pair of spermiducal glands, and that the sperm-duct, though it opens independently of the gland, is close to it on the same segment instead of being a segment in front; a difference of perhaps some importance is the fact that in *Microdrilus* the calciferous glands are arranged as they are in *Lumbricus*, i.e. they do not all communicate directly with the gut. As one undoubted *Acanthodrilus* (*A. monocystis*) has only a single pair of spermiducal glands, the line of demarcation between the Acanthodrilidae and the Cryptodrilidae becomes a very thin line.

Genus MICROSCOLEX, ROSA.

Syn. **Deltania,** EISEN.
Cryptodrilus, MICHAELSEN (in part.).
Rhododrilus, BEDDARD.

DEFINITION. **Setae strictly paired or distant; prostomium complete or incomplete; clitellum XIII (XIV)–XVI (XVII). Nephridia paired commencing in II–V. Gizzard present or absent; no calciferous glands. Spermathecae nearly always present, and, if so, with diverticulum. Spermiducal glands tubular with penial setae; male pores (on XVII, rarely XVIII) often separate from spermiducal gland pores.**

This genus was founded by ROSA (**17**), who described a single species from Italy under the name of *M. modestus*. Later, the same author added FLETCHER'S '*Eudrilus dubius*' to the genus, having met with that species and with *M. modestus* in the Argentine. A third species of the genus, as I define it in the present work, is a worm which I (**37**) originally referred to a distinct genus *Rhododrilus*. That genus was defined as follows:—'Setae in eight rows. Clitellum occupying segments xiv–xvii; atria tubular; penial setae present; vasa deferentia opening on to the exterior in the same segment (xvii), but independently of atria; gizzard present.'

The foundation of this new genus was, I think, justifiable at the time. But it cannot be any longer retained. The principal point of difference from *Microscolex* was (supposed to be) the separate orifices of the sperm-ducts and the spermiducal

glands. We now know that precisely the same separation occurs in *M. modestus*. It is not, therefore, requisite to do more than merely mention the fact that Eisen (**16**), in ignorance of the condition obtaining in *M. modestus*, resuscitated my genus *Rhododrilus*. The last-mentioned authority has founded a third genus *Deltania*. This genus, which contains three species from California, is distinguished from *Microscolex* by the fact that the ventral setae in the neighbourhood of the male pores converge towards each other. This condition had been before described in other species of *Microscolex*, which Eisen accordingly referred to *Deltania*. Since Eisen proposed this division nine new species of the genus have been studied by myself from South America. If it is necessary to subdivide *Microscolex*, these new species perhaps offer rather better characters. All of them differ from *M. modestus*, &c., in having but a single pair of male gonads instead of two pairs. As some have strictly paired setae instead of the eight rows formerly considered distinctive of both *Microscolex* and *Deltania*, the approximation of the ventral setae to each other on some of the genital segments loses its importance. Were these species the only species of the genus to be found in South America I should be inclined to regard the single testes and sperm-ducts to be a structural character requiring recognition by generic separation. As, however, both *M. dubius* and *M. modestus* appear to be indigenous inhabitants of the same part of the world this division seems to be less necessary. As it is unaccompanied by any other character which is equally distinctive, I prefer to leave the genus *Microscolex* undivided. The genus is quite easily definable as will be seen from the above definition. The eighteen species are of very varied sizes; at one extreme we have Michaelsen's '*Cryptodrilus spatulifer*,' which I cannot separate from the genus. At the other extreme there are specimens of *M. modestus*, only 16mm. long, and these are among the smallest of earthworms. The head-quarters of the genus is evidently in America, where fourteen of the species occur; of these only two, viz. *M. modestus* and *M. dubius*, occur outside this region. Nine are absolutely confined to South America, to the more temperate regions of that continent. The following is a list of the species:—

(1) **M. modestus,** Rosa, Italy; Argentine.
(2) **M. dubius** (Fletcher), Australia; Argentine.
(3) **M. algeriensis,** F. E. B., Algeria.
(4) **M. poultoni,** F. E. B., Teneriffe.
(5) **M. minutus,** F. E. B., New Zealand.
(6) **M. novae-zelandiae,** F. E. B., New Zealand.
(7) **M. spatulifer** (Mich.), South America.

(8) **M. griseus**, F. E. B., South America.
(9) **M. robustus**, F. E. B., South America.
(10) **M. michaelseni**, F. E. B., South America.
(11) **M. papillosus**, F. E. B., South America.
(12) **M. gracilis**, F. E. B., South America.
(13) **M. corralensis**, F. E. B., South America.
(14) **M. diversicolor**, F. E. B., South America.
(15) **M. longiseta**, F. E. B., South America.
(16) **M. elegans** (EISEN), California.
(17) **M. troyeri** (EISEN), California.
(18) **M. benhami** (EISEN), California.
(19) **M. monticola**, F. E. B., New Zealand.

(1) Microscolex modestus, ROSA.

M. modestus, ROSA, Boll. Mus. Zool. Torino, vol. ii, 1887, No. 19.

Definition. *Length*, 35–60 *mm.; number of segments, about* 75. *Setae in eight rows. Nephridia commence in segment IV. Gizzard rudimentary. Spermathecae one pair with a small diverticulum. Penial setae present. Testes in X, XI. Sperm-ducts open on segment behind spermiducal glands. Hab.—Argentina*; *Patagonia*; *Italy* (?).

The discovery of this species in the Argentine [ROSA, **6**] renders it possible that Italy is not its true habitat; as a matter of fact there is a considerable traffic between Genoa (in the neighbourhood of which the worm was first found) and the Argentine Republic—particularly in the way of emigrants. In addition to the points mentioned above this species differs from the closely-allied *M. dubius* in the white clitellum (instead of orange-coloured); it is morever, according to Captain Spegazzini, phosphorescent. ROSA has pointed out that in this case it is no longer possible to be certain that the '*Lumbricus phosphoreus*' of DUGÈS is really identical with *Photodrilus;* it may well be the present species.

(2) Microscolex dubius (FLETCHER).

Eudrilus (?) **dubius**, FLETCHER, Proc. Linn. Soc. N. S. W., vol. ii (2), 1887, p. 378.
M. dubius, ROSA, Ann. Mus. Civ. Genova, vol. ix (2a), 1889, p. 511.

Definition. *Length*, 50–70 *mm.; number of segments*, 110–120. *Setae in eight rows, ventral converging on genital segments. Nephridia commence in segment V. Gizzard absent. Spermathecae absent. Sperm-ducts join spermiducal glands about half way*

along the muscular tube of the latter; penial setae present. Testes in X, XI. Hab.—Argentina; Australia (?).

This appears to be a very common worm in the Argentine; a large collection of earthworms, which I received from the neighbourhood of Monte Video through the kindness of Mr. Chamberlain, consisted almost entirely of this species. So did the bulk of the specimens collected near Buenos Ayres by Dr. MICHAELSEN. It is unintelligible why FLETCHER should have at first referred it to the genus *Eudrilus*, for he correctly states the many and important points in which it differs from that genus.

(3) Microscolex algeriensis, BEDDARD.

M. algeriensis, BEDDARD, P. Z. S., 1892, p. 29.

Definition. *Length,* 30 *mm.; number of segments, about* 90. *Setae in eight rows. Nephridia commence in segment II. Gizzard absent. Spermathecae one pair, with a small diverticulum. Sperm-ducts unite and traverse a part of the thickness of body wall before joining duct of spermiducal gland. No penial setae. Testes in X, XI. Hab.—Algeria.*

This is the only species of the genus which is without penial setae. On the seventeenth segment the ventral setae are quite normal, the male pore lying on each side just to the outside of the ventralmost setae. The absence of penial setae is, of course, a point of resemblance to the closely-allied *Pontodrilus*, which is not shared by the other species of the genus. The brain lies in the second segment, whereas in the species next to be described it is in the more usual position, viz. in segment iii.

(4) Microscolex poultoni, BEDDARD.

M. Poultoni, BEDDARD, loc. cit., p. 32.

Definition. *Length, about* 30 *mm. Setae in eight rows, ventral converging on genital segments. Nephridia commence in segment II. Gizzard absent. No spermathecae; testes in X, XI. Sperm-ducts, after uniting together, pierce the body-wall and unite with the spermiducal gland just at its opening on to the exterior. Penial setae present. Hab.—Madeira.*

I have figured the penial setae of this species (**38**, fig. 2, p. 34), which are quite unornamented. There are no figures of the penial setae of the two other species which possess penial setae; but it appears from the descriptions that their form is not at all different from those of the present species. The first nephridiopore lies, as mentioned in the above definition of the species, on the second segment, but the nephridium itself chiefly lies in the following segment, i.e. the third. This extension

backwards of the nephridium is rendered possible by the absence of the septa in this region of the body, which do not commence until the fifth segment (v/vi); *M. algeriensis* agrees with the present species in both these points.

(5) Microscolex minutus, Beddard.

Rhododrilus minutus, Beddard, P. Z. S., 1889, p. 381.

Definition. *Length,* 3 *in. Clitellum, XIV–XVII. Setae of ventral couples closer together than of outer anteriorly; posteriorly both equidistant. Dorsal pores present after clitellum. Gizzard in segment V. Septa dividing segments VI/XII specially thickened. Spermathecae four pairs in VI–IX. Penial setae present. Sperm-ducts open independently of glands. Hab.—New Zealand.*

This species is peculiar in possessing four pairs of spermathecae. In this it approaches the more highly organized Cryptodrilids, particularly the genus *Megascolides.* The diverticula are very nearly as large as are the spermathecae themselves; both are tubular in form. The spermiducal glands extend through seven segments.

(6) Microscolex novae-zelandiae, Beddard.

M. novae-zelandiae, Beddard, P. R. Phys. Soc., 1893, p. 33.

Definition. *Length,* 42 *mm.; diameter,* 2 *mm.; number of segments,* 76. *Clitellum, XIII–XVII. complete except in XVII, where are paired male pores. Setae paired, but not very closely. Nephridia commence in II. Gizzard very rudimentary in V; intestine begins in XVI. Septa separating segments VIII/XIII slightly thicker than the rest. Penial setae without ornamentation. Spermathecae in IX with two diverticula. Hab.—New Zealand.*

This species has three papillae in neighbourhood of male pores, one in front and two just behind apertures arranged so as to form a triangle.

(7) Microscolex spatulifer (Michaelsen).

Cryptodrilus (?) spatulifer, Michaelsen, JB. Hamb. wiss. Anst., vi, 1889, p. 10.
Cryptodrilus spatulifer, Beddard, P. R. Phys. Soc., 1893, p. 31.

Definition. *Length,* 145 *mm.; number of segments,* 146. *Prostomium complete. Setae strictly paired. Clitellum, XIII–XVII. Gizzard in VI; intestine begins in XVIII. Gonads one pair only; sperm-sacs in XI; spermathecae in IX, with large caecum; racemose at distal end. Penial setae with crenate ridges. Hab.—Chili.*

My account of its anatomy substantially bears out that given by MICHAELSEN, excepting only as regards the form of the prostomium. I found it to completely divide the buccal ring. The colour of the spirit specimens of this species is a dark purple red dorsally. The penial setae are ornamented by serrated ridges at the free extremity.

(8) Microscolex griseus (NEW SPECIES).

Definition. *Length, 84 mm.; diameter, 5 mm.; number of segments, 117. Setae strictly paired. Dorsal pores present. Prostomium complete. Clitellum, XIII–XVII. Gizzard in VI. Sperm-sacs in IX, XI. Testes in X. Spermathecae in IX, with large stalked diverticulum. Penial setae with spinelets. Hab.—Valparaiso.*

This is one of the largest species of the genus. It is when alive of a dirty grey colour ; more flesh-coloured in front. There is a median genital papilla upon xvi.

(9) Microscolex robustus (NEW SPECIES).

Definition. *Length, 72 mm.; diameter, 7 mm.; number of segments, 82. Setae distant, the ventral setae converging on segments XIII–XX. Clitellum, XIV–XVII. Dorsal pores absent. Prostomium complete. Gizzard in VII. Sperm-sacs in IX, XI. Testes in X. Penial setae long and unornamented. Spermathecae small in IX, with tubular diverticulum. Hab.—Teja Island, Valdivia.*

There are a number of genital papillae, paired on ix, xv, xvi ; three on xvii, xviii.

(10) Microscolex michaelseni (NEW SPECIES).

Definition. *Length, 85 mm.; diameter, 3 mm.; number of segments, 92. Setae more closely paired ventrally than laterally. Clitellum, XIII–XVII. Prostomium incomplete. Gizzard rudimentary. Sperm-sacs in XI. Testes in X. Sperm-duct opens behind spermiducal gland on to a groove. Penial setae with spinelets. Spermathecae in VIII, each with two short diverticula. Hab.—Magellan's Straits, Uschuia, Navarin Island, S. America.*

This species is aquatic as well as terrestrial. It is quite bleached by alcohol, and has therefore presumably no integumental pigment when alive. The sperm-ducts and glands open on to a crescentic groove, which extends on to segment xviii. It sometimes happens therefore that the male pores are on xviii.

(11) **Microscolex papillosus** (NEW SPECIES).

Definition. *Length,* 87 *mm.; diameter,* 3 *mm.; number of segments,* 95. *Setae paired. Prostomium incomplete. Clitellum, XIII–XVI. Dorsal pores absent. Genital papillae upon VII–XVII, median unpaired. Gizzard in V. Sperm-sacs in IX, XI. Testes in X. Spermathecae in IX, with spiral diverticulum. Sperm-duct opens just free from spermiducal gland. Penial setae of enormous length* (10 *mm.*), *unornamented. Hab.—Uschuia, S. America.*

This species is another of those which have a purple colour. Just in front of the male pores is a deep depression of the integument. This is attached by muscular fibres to the dorsal parietes, and is lined by a tall columnar epithelium. It probably serves as a sucker. The male pores and those of the spermiducal glands open upon very prominent papillae. The diverticulum of the spermathecae ends in a swollen extremity which alone is glandular in structure, being lined by a much-folded epithelium.

(12) **Microscolex gracilis** (NEW SPECIES).

Definition. *Length,* 72 *mm.; diameter,* 2 *mm.; number of segments,* 88. *Setae distant. Prostomium incomplete. Clitellum, XIII–XVI. No dorsal pores. Gizzard in VI. Sperm-sacs in XI. Testes in X. Spermathecae in IX, with a single stalked diverticulum. Sperm-duct opens into duct of spermiducal gland at some distance from pore. Penial setae not ornamented. Hab.—Uschuia, S. America.*

This species has the same colouration as *M. diversicolor*, and might be confounded with it at first sight. But the incomplete prostomium of the present species serves to differentiate them even without having recourse to the internal structure. It has unusually large ovaries, which however occupy the normal position. The sperm-duct opens on to a papilla, which projects into the interior of the muscular duct of the spermiducal gland.

(13) **Microscolex corralensis** (NEW SPECIES).

Definition. *Length,* 40 *mm.; diameter,* 4 *mm.; number of segments,* 70. *Setae paired. Prostomium complete. Dorsal pores present. Clitellum, XIII–XVII. Male pores widely separated. Gizzard in VI, VII. Sperm-sacs in XI. Testes in X* (?). *Spermathecae in IX, with oval diverticulum. Penial setae markedly ornamented with transverse ridges. Hab. – Corral, Valdivia, S. America.*

(14) Microscolex diversicolor (NEW SPECIES).

Definition. *Length, 52 mm.; diameter, 3·5 mm.; number of segments,* 60. *Setae distant. Prostomium complete. Dorsal pores present. Clitellum, XIII–XVI. Gizzard in VI. Testes in X. Sperm-sacs in IX, XI. Spermiducal gland opens separately from sperm-duct, but near. Penial setae unornamented. Spermathecae in IX, with one large diverticulum. Hab.—Corral, Valdivia.*

This species varies a good deal in size. I found a few specimens which, though sexually mature, were only 30 mm. in length, and consisted of 100 segments.

(15) Microscolex longiseta (NEW SPECIES).

Definition. *Length,* 40 *mm.; diameter,* 3 *mm.; number of segments,* 95. *Setae strictly paired. Prostomium incomplete. Dorsal pores present. Clitellum, XIII–XVI, incomplete. Gizzard in VI. Sperm-sacs in XI. Spermathecae in IX, with long spirally coiled diverticulum. Penial setae* 6 *mm. long. Hab.—Uschuia, Puerto Pantalon, Puerto Toro (Navarin); in S. America.*

This species comes very near to *M. papillosus.* It has the same inordinately long penial setae and the same curious spiral diverticulum to the spermatheca. It is, however, so much smaller and so devoid of pigment that, as I have examined a large number of individuals, I feel obliged to separate the species. There are sometimes, however, traces of a faint purple colour dorsally.

(16) Microscolex elegans (EISEN).

Deltania elegans, EISEN, Zoe, iv, 1893, p. 251.

Definition. *Length,* 100 *mm. Prostomium incomplete. Clitellum, XIII–XVII. Setae in eight rows, ventral converging on genital segments. No dorsal pores. Nephridia commence in II. No gizzard. Spermathecae single or a pair, without diverticula. Testes in X, XI. Sperm-ducts open into spermiducal gland within body-wall. Penial setae not ornamented. Hab.—San Francisco and neighbourhood.*

This and the two following species were assigned by EISEN to a new genus, *Deltania,* which was stated to differ from *Microscolex* 'principally by the deltoid arrangement of the setae in the vicinity of the male pore.' I am not inclined to allow a separate genus for it. It will be seen that, apart from this very slight difference, the species which are enrolled by EISEN in that genus show no really

important points of unlikeness from *Microscolex*. The present species is without egg-sacs and gizzard. The most remarkable characteristic is said by EISEN to be the spermatheca, which is sometimes a median unpaired structure and sometimes paired; it has, too, excessively thin walls. There are septal glands in segments vi–ix; in vi–viii or v–viii in the two following species. These structures do not seem to occur in other species of the genus. This and the two following species are more fully described by EISEN in (**16**).

(17) Microscolex troyeri (EISEN).

Deltania Troyeri, EISEN, loc. cit., p. 251.

Definition. *Length*, 30 *mm. Prostomium incomplete; no dorsal pores. Clitellum, XIII–XVII. Setae in eight rows, ventral converging on genital segment. No gizzard. Spermathecae with paired diverticula. Sperm-ducts open into spermiducal glands within body-wall. Penial setae not ornamented. Hab.—Golden Gate Park, San Francisco.*

(18) Microscolex benhami (EISEN).

Deltania Benhami, EISEN, loc. cit., p. 252.

Definition. *Length*, 25 *mm. Prostomium incomplete; no dorsal pores. Testes in X, XI. Clitellum, XIII–XVII. Setae in eight rows, ventral converging on genital segments. No gizzard. Spermathecae in IX, with two small diverticula. Spermiducal glands open into spermiducal gland within body-wall. Penial setae not ornamented. Hab.—Alameda county, California.*

(19) Microscolex monticola (NEW SPECIES).

Definition. *Length*, 31 *mm.; diameter*, 3 *mm.; number of segments*, 79. *Setae paired, dorsal wider apart than ventral. Prostomium complete. Dorsal pores present. Gizzard in VIII* (?). *Testes in X, XI. Sperm-sacs in XII. Spermathecae in IX, with two diverticula. Spermiducal glands long and coiled. Penial setae* (?). *Hab.—Mount Pirongea, Auckland, New Zealand.*

In alcohol the single example of this species, which I owe to the kindness of Capt. Brown, was almost black in colour, the setae being implanted upon a white ground. There was no clitellum.

Genus PONTODRILUS, Perrier.

Syn. **Lumbricus**, Grube (in part.).
Pontoscolex, Schmarda (in part.).
Cryptodrilus, Rosa (in part.).
Photodrilus, Giard.

Definition. **Slender worms with eight setae per segment, in pairs, the setae of the dorsal pair being usually further apart than those of the ventral. No dorsal pores. Clitellum complete, XIII-XVII. Male pores XVIII. Spermiducal gland tubular, vasa deferentia opening at junction of glandular and muscular parts. No penial setae. Spermathecae in VIII, IX, with single diverticulum. Gizzard absent or rudimentary; no calciferous glands. Nephridia commence in segment XIII or XV. No subnervian blood-vessel.**

The principal parts in the structure of this genus have been treated of in considering the characters of the family to which it belongs. Its anatomy was described in great detail by Perrier (**9**) ten years ago; since that time I have pointed out that certain structures considered by Perrier to be of doubtful import, are the testes, and that the gizzard is not entirely absent, as he thought, though undoubtedly very rudimentary. I have already given reasons for uniting Giard's *Photodrilus* with *Pontodrilus;* one other species should, I think, be extracted from the heterogeneous assemblage of forms described under the name of '*Cryptodrilus*' and added to *Pontodrilus*.

The genus *Pontodrilus*, as I define it here, will therefore contain the five following species:—

(1) **P. littoralis.** European coasts.
(2) **P. bermudensis.** Brazil; Bermudas; Jamaica.
(3) **P. hesperidum.** Jamaica.
(4) **P. insularis.** Aru Islands.
(5) **P. phosphoreus.** North France.

The latter species is placed by Rosa in the genus *Cryptodrilus*, but not in a decided fashion; he remarks that it is only provisionally so placed, pending a revision of the family Cryptodrilidae. The reasons which lead me to place it in the present genus are, in the first place, the fact that the nephridia do not commence until the thirteenth segment—a character which is only met with in the genus *Pontodrilus* (among the Cryptodrilids); the gizzard, too, is absent, and there are no calciferous glands. These latter characters, as well as a few others, are not distinctive

of the genus *Pontodrilus;* they would not be of themselves sufficient to place the species in the present genus, but they confirm the justice of this placing.

(1) Pontodrilus littoralis (GRUBE).

Lumbricus littoralis, GRUBE, Arch. f. Nat., 1855, p. 127.
Pontodrilus Marionis, PERRIER, C. R., 1874, p. 1582.

Definition. *Length,* 100 *mm.; diameter,* 4 *mm.; number of segments,* 115. *Papillae on XX, XXI. Spermathecae with a single diverticulum in VII, VIII. Sperm-sacs in XI, XII. Gizzard rudimentary. Hab.—Shores of Mediterranean.*

There can be hardly any doubt that all the forms described under the above two names are representatives of one and the same species, in spite of the great distance which divides the localities where they occur. *P. littoralis* and '*P. marionis*' have been met with at Villa Franca and Marseilles by GRUBE and MARION; I received, through the kindness of my late friend Dr. George Hoggan, specimens from Nice. A year or two since I briefly mentioned in the 'Annals and Magazine of Natural History' the existence of *Pontodrilus* at the Bermudas; I assumed that this form was different from the Mediterranean *Pontodrilus.* A more careful examination of those specimens has confirmed the justice of separating them from the European form. As to '*P. marionis,*' PERRIER regarded it as distinct from *P. littoralis* mainly on account of the differences shown in the genital papillae, but at the same time remarks that the matter must be regarded as doubtful, since he (M. PERRIER) had received examples of the supposed species '*P. marionis*' from the exact locality which furnished *P. littoralis.* A curious fact about this earthworm (and the next) is its habitat. It has been hitherto only met with upon the sea-shore, generally among masses of sea-weed; the only other species of earthworm which inhabits the same locality is *Pontoscolex arenicola.* The living specimens of *Pontodrilus* received from Nice were colourless, that is to say there was no integumental pigment; their reddish colouration was manifestly due to the blood-vessels.

(2) Pontodrilus bermudensis, BEDDARD.

P. bermudensis, BEDDARD, Ann. & Mag. Nat. Hist., Jan. 1891, p. 222.
P. arenae, MICHAELSEN, Arch. f. Nat., 1892, p. 222.
Pontoscolex arenicola, SCHMARDA, Neue wirbell. Thiere, Bd. I, ii, p. 11 (in part.).

Definition. *Length,* 80 *mm.; number of segments,* 120. *Setae ornamented, present on eighteenth segment at opening of male ducts. One median papilla between XIX/XX. Hab.—Bermudas; Jamaica; Brazil (sea-shore).*

This species was originally described by myself from specimens obtained on the island of Bermuda[1] (**24**). The description, however, was not at all sufficient to recognize the species, and I subsequently arrived at the conclusion that the supposed species was identical with *P. littoralis.* MICHAELSEN'S description of his *P. arenae* led me to look into the matter again, and as a result I found that my species from Bermuda was probably identical with this *P. arenae.* Some of the specimens of SCHMARDA'S *Pontoscolex arenicola* proved also to belong to this same species, though it is not necessary on that account to retain this name for the species, for as his figure evidently refers to a '*Urochaeta,*' I retain that name for the genus and for a species of what used to be known by PERRIER'S name of *Urochaeta hystrix.* My name, however, should evidently have the priority. Since writing the extremely imperfect account of *P. bermudensis* already quoted, I have re-examined the worm, and find myself able to confirm MICHAELSEN in every particular, though I can add a few minutiae to his description. The male pores open into a long groove which occupies the whole of the segment; there is, of course, a groove on each side. This and the fact that there is only a slight genital papilla distinguishes, as regards external characters, the present species from *P. littoralis.* The ornamentation of the setae does not occur, so far as I have been able to make out, in the European *Pontodrilus;* the setae are not modified upon the eighteenth segment, and are present. The muscular duct of the spermiducal gland is much more pronounced in the New World than in the Old World *Pontodrilus.* MICHAELSEN found the nephridia to commence in the thirteenth segment; I found that more usually they began in xv, but in one specimen in xiii. The clitellum occupies segments xiii–xvii. In other anatomical characters this species does not depart from *P. littoralis.* The specimens from Bermudas and from Jamaica had their entire alimentary tract filled with the débris of coral rock. So abundantly was the intestine filled with calcareous débris that the body was in places distended beyond its normal size. There was nothing in the gut except this sand; no traces of vegetable matter for example. One is disposed therefore to think that the worms must nourish themselves largely upon the minute animals (Foraminifera, &c.), living among the coral detritus. The absence of a gizzard

[1] The increase of synonyms is largely my own fault; Dr. MICHAELSEN wrote to me to inquire if my *P. bermudensis* agreed with certain characters of a new species which he had in his possession and afterwards described as *P. arenae;* I could not see any ornamentation in the setae, expecting something more pronounced than what actually is found. I have since satisfied myself beyond a doubt that these setae are ornamented.

among the aquatic Oligochaeta has usually been put down to the soft nature of their food; just as graminivorous differ from carnivorous birds by the increased muscularity and internal thickening of the analogous organ. But the 'food' of *Pontodrilus* would seem to need a gizzard for its trituration more than that of any other earthworm, and yet *Pontodrilus*, though it has a gizzard, has a very feebly developed one. I had expected that the Bermuda specimens would show a greater development of gizzard than those from the Mediterranean shores which feed upon soft sea-weeds, but this was not the case.

(3) Pontodrilus hesperidum, Beddard.

P. hesperidum, Beddard, P. R. Phys. Soc., 1893, p. 37.

Definition. *Length, about* 25 *mm.; diameter,* 1·5 *mm. Setae paired, but the individual seta rather distant; setae* 2 *of segment XVIII absent. Septa V/XIII are thickened, and particularly the last three. Gizzard entirely absent; intestine begins in XV. Last hearts in XIII. Sperm-sacs in XI, XII. Hab.—Jamaica.*

This is the smallest species of the genus, but as the single individual examined by myself was immature, the account I have given of it was not complete. There is, however, no danger of confounding it with any other species of the genus. The enormous thickness of some of the anterior septa is a noteworthy point about it. I have mentioned in my description of the species that the spermiducal glands are lined by a single layer of cells. This may be simply due to immaturity.

(4) Pontodrilus insularis (Rosa).

Cryptodrilus insularis, Rosa, Ann. k. Hofm. Wien, vi, 1891, p. 387.

Definition. *Length,* 50 *mm.; diameter,* 3 *mm.; number of segments,* 100. *Septa VI/XIII very greatly thickened. Rudimentary gizzard in VII. Sperm-sacs in XI, XII. Spermathecae in VIII, IX, without diverticula. Hab.—Aru Island.*

This species was not definitely referred to the genus *Cryptodrilus* by Rosa, but only 'provisionally,' pending a revision of the family; there can be no doubt, I think, that it is rightly referable to the genus *Pontodrilus*, as defined in the present work; the nephridia do not commence until the thirteenth segment, a character which is found in all the species of the genus, though there is some variation in the actual

segment at which they first appear. Rosa examined only two immature examples and his account of the species is therefore not very full.

(5) Pontodrilus phosphoreus (Dugès).

Lumbricus phosphoreus, Dugès, Ann. Sci. Nat. viii (2), 1837, p. 17.
Photodrilus phosphoreus, Giard, C. R., 1887, p. 872.

Definition. *Length, 50 mm.; diameter, 2 mm.; number of segments,* 110. *Setae in eight rows. Clitellum, XIII–XVII. Hearts in X–XII. Sperm-sacs in XI, XII. Spermathecae in IX with a diverticulum. Hab.—France.*

This species has been investigated by Giard, who however has not yet published an illustrated account of his researches. The main facts in its structure are given in the above definition. In addition to the points there mentioned there exist on segments xii, xiii, and xviii sacs of modified setae in addition to the ordinary ventral setae; instead of a bundle of about four setae there is sometimes only a single seta. This worm appears to be luminous at night, whence the name given to it by Dugès.

Genus TYPHAEUS, Beddard.

Definition. **Clitellum, XIII–XVII; male pores on XVII. Nephridia diffuse. Testes and funnels a single pair. Spermathecae a single pair. Spermiducal glands tubular, furnished with penial setae.**

This genus was founded by myself in 1883 for an earthworm from Calcutta; since that time four additional species have been made known by Bourne (**3**), Rosa (**8**), and myself (**48**). Without exception all the species of the genus are natives of India, Ceylon, and Burmah. Although the above definition will serve to distinguish *Typhaeus* from any other genus of the Cryptodrilidae, there are other characters which are very possibly of generic value, in addition to those already made use of. I have not used these in the definition inasmuch as no definite statements have been made about certain of them in the two species examined by Rosa, which were in a very poor condition for anatomical examination. In all the three species of whose anatomy we possess at all sufficient data the intestine is furnished with a series of about six pairs of reniform glands lying on its dorsal surface. I have described these in *T. orientalis* and *T. gammii;* Bourne has referred to them in *T. masoni;* their minute

structure has been briefly described and figured by me (**48**) in *T. gammii*. The glands are made up of a much-folded membrane; their interior is thus divided up into numerous compartments by the folds which seem to anastomose; the structure of the glands is in fact extremely like that of the calciferous glands. Another character of *Typhaeus* possibly of generic value, i.e. not confined to the species in which alone it has been recorded, is the fact that there is only a single pair of calciferous glands.

It is unusual among the Cryptodrilidae for the testes to be limited to one pair: there is no other genus in which this is, as it is in the present, a character which runs through all the species. Corresponding to the single pair of testes and funnels we have only a single pair of sperm-sacs; these are long and tongue-shaped and extend through several segments as in many Geoscolicidae.

The spermiducal glands are long and tubular; the actual mode of their opening on to the exterior has only been studied in *T. gammii*. In that species, and very possibly in the others, the sperm-duct perforates the body-wall independently and only joins the gland just before the opening of the latter on to the exterior; the cells of the sperm-duct are ciliated up to the point where they perforate the body-wall, after this they lose the cilia. Opening in common with the spermiducal gland on each side of the body is a sac containing a bundle of penial setae.

(1) Typhaeus orientalis, Beddard.

T. orientalis, Beddard, Ann. Mag. Nat. Hist., Oct. 1893, p. 219.

Definition. *Length*, 250 *mm. Setae strictly paired. Genital papillae between segments XIII/XVII, XVIII/XX, on a line with ventral setae. Intestinal glands five pairs. Hab.—Neighbourhood of Calcutta.*

I have described the outer pair of setae as being absent from the clitellar segments of this species; as, however, I have had no opportunity of verifying this upon fresh material I do not utilise the character, if it be really constant, as part of the definition of the species. The gizzard appeared to occupy two segments, the septum dividing which has aborted as in the genus *Perichaeta* (s. s.); there are only two specially thickened septa, which lie between segments v/vii. The last heart is in segment xiv (?)[1].

(2) Typhaeus gammii, Beddard.

T. gammii, Beddard, Q. J. M. S., vol. xxix, 1889, p. 111.

Definition. *Length, about* 250 *mm.; thickness up to half-an-inch. Setae strictly paired.*

[1] See remarks upon the following species.

A single large genital papilla between XIX/XX and XX/XXI. Intestinal glands of consecutive segments fused. Hab.—Darjeeling.

This species can be distinguished from the last by its greater bulk. It is true that the measurements given appear to indicate a similar size; but the specimens of *T. orientalis* which I examined were much softened and extended, whereas those of *T. gammii* were retracted. *T. gammii* also seems to differ from the last species in having no setae upon the second segment of the body. At the time that this fact was mentioned by me there was no earthworm known in which the setae were absent from any but the first segment; I therefore mentioned it with greater hesitation than it would be necessary to do now when so many species are known in which this amount of 'cephalization' is met with. The dorsal pores commence between the tenth and eleventh segments.

The first distinct septum lies between segments iv/v; three thickened septa border segments vii, ix, x posteriorly. The gizzard is in segments vi, vii; the septum which should divide these segments is absent, or at most is represented by two muscular bands which tie down the gizzard to the parietes. These muscles also occur in the last species. Accepting Bourne's corrections of my enumeration of the segments, I should now refer the single pair of calciferous glands to the thirteenth instead of to the twelfth segment. This segment also contains the last pair of hearts. I expect that a renewed examination of the last species would show that there also the last pair of hearts occupy the same segment.

The single pair of testes in the eleventh segment are enclosed within a median unpaired sperm reservoir. The two sperm-sacs are long, reaching back to the seventeenth segment; the sperm-sacs are racemose in form. The spermathecae have, as in the last species, two diverticula; but each of these is multifid instead of being trifid. The shape of the penial setae distinguish this species from *T. orientalis;* their free extremity is covered by numerous finely denticulate ridges, whereas in the last species the extremity of the seta has fine obliquely running ridges which give it a bipinnate appearance.

(3) Typhaeus masoni, Bourne.

T. Masoni, Bourne, J. Asiat. Soc. Bengal, vol. lviii, p. ii. p. 112.

Definition. *Length,* 130 *mm. Setae paired anteriorly; in posterior segments they come to be separated. Genital papillae paired between segments XV/XVI, XVI/XVII, XVIII/XIX, XIX/XX. Four pairs of bilobed intestinal glands. Hab.—Dehra Dun.*

This species has been described by BOURNE; it chiefly differs from the two species that have been just described in the fact that the setae, as in *Geoscolex*, become separated by greater intervals posteriorly, being strictly paired anteriorly. The anterior segments are annulate, as in *T. gammii*, and it is quite possible that there are no differences between the two species in the number of the genital papillae; these structures vary so much in number in individuals that it is most unsafe to draw any distinctions based upon apparent differences that they show. The calciferous glands of this species, though agreeing with those of *T. gammii* in being limited to a single pair, are situated in a different segment, i.e. the eleventh or the twelfth.

BOURNE has stated that the sperm-duct opens into the muscular duct of the spermiducal gland just before the latter penetrates the body-wall; the penial setae are remarkable for the fact that each sac contains setae of two kinds—a somewhat unusual occurrence among the Oligochaeta, though seen in *Acanthodrilus georgianus*; some of the setae are smooth at the free extremity, others have the chevron-shaped markings that occur in the penial setae of *T. orientalis*; the caecal appendages of the spermathecae are bifid or trifid.

(4) Typhaeus laevis, ROSA.

T. laevis, ROSA, Ann. Mus. Civ. Genova, vol. ix (2 a), 1889, p. 388.

Definition. *Length, 35 mm.; number of segments,* 180. *Genital papillae, two pairs on XVII and XVIII. Hab.—Burmah; Ceylon.*

This species is only very imperfectly known; nothing with regard to the internal characters is contained in ROSA's (**8, 11**) account of the species. It is to be distinguished from the three foregoing by its smaller size and by the characters of the papillae. In addition to these distinguishing marks the present species seems to differ by the arrangement of the setae; the two setae of the dorsal pair are separated by wider intervals than are the setae of the ventral pair. Dorsal pores were seen from the intersegmental groove xii/xiii.

(5) Typhaeus foveatus, ROSA.

T. foveatus, ROSA, loc. cit., p. 389.

Definition. *Length,* 180 *mm.; number of segments,* 170. *No genital papillae. Penial setae with minute points irregularly arranged upon the free end. Hab.—Rangoon.*

This species is not well known; it is not easy to distinguish it from the last; the specimens examined by ROSA were immature; the absence, therefore, of genital

papillae may very possibly not be a character of specific value; the setae appear to be arranged much as in the last species, as will be seen by a comparison of what ROSA has said with regard to the two worms.

T. laevis.

Le setole dorsali 3–4 sono sempre più distanti fra loro che le ventrali 1–2, lo spazio fra le ventrali e le dorsali nella parte anteriore del corpo e un po' maggiore di quello fra le due setole d' ogni paio per cui queste sono geminate ma non strettamente posteriormente pero le paia ventrali e dorsali si ravvicinano, per cui lo spazio (2–3) che sta fra le seta o le ventrali e le dorsali e maggiore di quella fra le ventrali (1–2) e minore di quello fra le dorsali (3–4).

T. foveatus.

Le due setole nelle paia esterne (3–4) sono distanto fra di loro circa il doppio che nelle interne (1–2): lo spazio fra le due paia di un lato (2–3) e maggiore di quello fra le setole esterne (3–4), minore pero dello spazio mediano ventrale (1–1). Tale disposizione è costante per tutta la lunghezza del corpo.

The dorsal pores commence between segments xi/xii. Concerning the external characters, only enough details are given to show that the present species agrees with the remaining species of the genus. Thickened septa exist between segments iv/vi, viii/xi; the penial setae appear to differ from those of the other species in which they are known by being ornamented at the extremity with a number of minute points arranged indefinitely; some of the setae are, however, smooth[1]; they are none of them swollen, but are curved; the diverticula of the spermathecae (two, as in other species) are simple without divisions; but then the specimen was immature, and the spermathecae are described as being slightly developed.

Genus DICHOGASTER, BEDDARD.

DEFINITION.—Setae paired. Dorsal pores present. Clitellum XIII–XX (XXIII). Male pores on XVII. Two gizzards; three pairs of calciferous glands. Nephridia diffuse. Spermiducal glands tubular.

This genus was created by myself for the reception of an earthworm from the island of Fiji, differing from any other Cryptodrilid in the fact that, behind the

[1] Cf. *T. masoni*, above.

spermiducal glands of the seventeenth segment, there are two pairs of tubular glands—a pair to each segment—of the same character, though rather smaller. MICHAELSEN (**10**) has, however, referred two earthworms from tropical Africa to the same genus, which do not show this peculiarity, though agreeing in most other matters with my *Dichogaster damonis;* by neglecting this character, and also the absence of the ventral setae upon segments xvii, xviii, xix, which both distinguish *D. damonis*, the genus *Dichogaster* is reduced to a condition in which it is very difficult to define it. The above definition, however, does exclude the genera *Cryptodrilus*, *Megascolides*, and *Digaster*, in a few comparatively trifling points; thus, in all of those genera the male pores are upon the eighteenth instead of the seventeenth segment. These differences cannot be looked upon as important; but then, hardly any of the points in which many of the genera of Cryptodrilidae differ are important; and it is necessary to divide so large a family into genera; I am not sure that it would not be advisable to retain the name *Dichogaster* for my species only, and to apply a new name to MICHAELSEN'S species, which show the differences referred to, and are, moreover, peculiar to the Ethiopian region. It may be noted also that there is nothing in MICHAELSEN'S description, which is opposed to uniting with his two species of '*Dichogaster*' my genus *Microdrilus* (q. v.). With these preliminary remarks I leave for the present the genus as MICHAELSEN has wished.

(1) Dichogaster damonis, BEDDARD.

D. damonis, BEDDARD, Q. J. M. S., vol. xxix, 1889, p. 251.

Definition. *Length, about* 4 *inches. Clitellum, XIII–XX. Ventral setae of XVII–XIX missing; three pairs of tubular glands open on to these segments, of which the anterior is connected with sperm-duct. A pair of peptonephridia open into buccal cavity. Hab.—Fiji.*

In this species the calciferous glands are in the fifteenth, sixteenth, and seventeenth segments. The single pair of spermathecae have a single diverticulum; this has very thick walls, and its cavity is much subdivided. I have illustrated the anatomy of this species in my memoir quoted above.

(2) Dichogaster mimus, MICHAELSEN.

D. mimus, MICHAELSEN, Arch. f. Nat., 1891, p. 202.

Definition. *Length,* 40 *mm.; number of segments,* 350. *Clitellum, XIII–XXIII. No penial setae. Hab.—Accra, West Africa.*

MICHAELSEN states that in this species the spermathecae open in the intersegmental groove viii/ix, whereas in the last species they open a segment in front of this; there is also a similar difference in the position of the calciferous glands, which in *D. mimus* are situated in segments xiv, xv, xvi. The absence of penial setae distinguishes this species and the preceding one also from the next to be described.

(3) Dichogaster hupferi, MICHAELSEN.

D. Hupferi, MICHAELSEN, J. B. Hamb. wiss., Anst., Bd. ix, 1891, p. 66.

Definition. *Length, 180 mm.; number of segments, 250. Dorsal pores commence XVIII/XIX. Penial setae present. Four sacs of copulatory setae by the spermathecae. Hab.—W. Africa.*

This species is obviously different from the last; but MICHAELSEN has been only able to give a short account of it; he has figured the two kinds of modified setae which are different in form, as in *Typhaeus masoni,* and in a species or two of *Acanthodrilus.* The presence of copulatory setae near the spermathecae also recalls the Acanthodrilidae.

Genus DEODRILUS, BEDDARD.

DEFINITION. **Prostomium absent. Setae strictly paired, truncated in form at the free extremity and ornamented with minute spinelets, absent on the first five segments of the body. Nephridia diffuse. Spermiducal glands lobate, with a sac of penial setae**

This genus is represented by only one species; it is not, therefore, possible to do more than distinguish in a tentative fashion the generic from the specific characters.

The two most marked features of the genus *Deodrilus* are, perhaps, the absence of a prostomium and the form of the setae. In no other genus of Cryptodrilidae is the prostomium aborted (or rather 'not yet developed,' should possibly be said in view of VEJDOVSKY's recent researches (**9**)). I have stated its absence in *Typhaeus;* but, as BOURNE has found a prostomium in the species, *T. masoni*, described by himself, and as ROSA also referred to the prostomium in the two species which he investigated, it is probable that *Typhaeus* is not, as I first stated, without a prostomium.

I have already commented upon the resemblance which this genus shows to the Geoscolicidae in this character, as well as in other points. The setae of *Deodrilus* are peculiar, as regards the Cryptodrilidae, in not having the regular sigmoid form; the extremity has a truncated appearance as if the end had been broken off;

moreover, the distal extremity is covered by numerous minute spines, a state of affairs rarely met with among the Cryptodrilidae; the only other instance, in fact, is *Pontodrilus arenae.*

It is possible that this genus is also to be distinguished by the presence of only a single pair of testes; at any rate, I could only discover one pair of funnels; there are, however, two pairs of sperm-sacs in x and xi; as the sperm-sacs generally correspond in number to the testes, the missing testes of the tenth segment may be ultimately forthcoming.

The spermiducal glands open on to the eighteenth segment; the penial setae are remarkable in being of two kinds (a not uncommon occurrence, however); there are setae with an ornamentation like that of the ordinary setae of the body; there are also setae of which the distal extremity has transverse ridges.

Deodrilus jacksoni, BEDDARD.

D. Jacksoni, BEDDARD. Q. J. M. S., vol. xxxi, 1891, p. 475.

Definition. *Length,* 325 *mm. Genital papillae forming a dumb-bell-shaped area between segments XI/XII. Two pairs of spermathecae without diverticula in VIII, IX. Hab.—Ceylon.*

The anterior segments of the body are annulated; the clitellum was not fully developed in the specimen which I examined; it appeared to extend from the fifteenth to the eighteenth segment. The genital orifices (upon the eighteenth segment) were borne upon two ridges coinciding in position with the ventral setae. The septa lying between segments vi/xiii are specially thickened. There is a gizzard in vi; the calciferous glands, which are bilobed, lie in segments xv, xvi, xvii; the intestine begins at about the twentieth segment. There appeared to be a 'mucous gland' lying beside the pharynx. I have illustrated the anatomy of this species in my paper quoted above.

Genus MILLSONIA, BEDDARD.

DEFINITION. Large worms, with strictly paired, ventrally placed setae. Male pores (paired or unpaired) on XVII. Nephridia diffuse. Two gizzards in V, VI. Calciferous glands in XV–XVII. Intestine with about thirty pairs of caeca. Spermathecae without diverticula. Spermiducal glands tubular. No penial setae.

This genus is to be distinguished by two very salient characters: (1) the large number of intestinal caeca, which entirely resemble the single pair of *Perichaeta;* and (2) the nephridia; the latter are anteriorly of the ordinary diffuse kind; posteriorly, apparently entirely through the inordinate growth of the vesicular peritoneal cells, each segment appears to be filled with a row of small oval sacs; these are merely the disguised nephridia.

(1) Millsonia rubens, Beddard.

M. rubens, Beddard, P. Z. S., 1894, p. 382.

Definition. *Length,* 320 *mm.; diameter,* 12 *mm.; number of segments,* 363. *Male pores paired. Clitellum, XIII–XXII. Spermathecae in VIII. Sperm-sacs in XI, XII. No bursa copulatrix. Hab.—Tropical W. Africa.*

The brick-red colour of the worm (in alcohol) suggested its name. The septa begin iv/v, but ix/x is the first which is thickened. The first five segments appear to be without setae (cf. *Deodrilus*).

(2) Millsonia nigra, Beddard.

M. nigra, Beddard, loc. cit., p. 385.

Definition. *Length,* 230 *mm.; diameter,* 7 *mm. Male pores single. Spermathecae in VII, opening VIII/IX. Spermiducal glands open each into a bursa copulatrix. Hab.—Tropical W. Africa.*

The colour of the preserved worm is a very dark brown. As in the last species, there are dorsal pores. The distal end of the sperm-ducts has a muscular sheath, and opens separately from the spermiducal gland into the bursa. The latter is a thick-walled sac, something like that of *Geoscolex,* and seven mm. long. The spermathecae perforate septum vii/viii, and come to lie in the former segment, though the external pore is between viii/ix. The very first septum (iv/v), and thence to xiii/xiv, are thickened.

Genus FLETCHERODRILUS, Michaelsen.

Syn. **Cryptodrilus,** Fletcher (in part.).

Definition. Setae in eight rows. Male pore and spermathecal pores in a single median unpaired series. Nephridia paired. Spermiducal glands tubular. Spermathecae one to each segment, with a pair of diverticula. No penial setae.

I follow MICHAELSEN in allowing only a single species of this genus, which must be named—

Fletcherodrilus unicus, FLETCHER.

Cryptodrilus (?) unicus, FLETCHER, Proc. Linn. Soc. N. S. W., iii. (2), 1889, p. 1540.

C. purpureus, MICHAELSEN, JB. Hamb. wiss. Anst., vi, 1889, p. 3.

Cryptodrilus (?) purpureus, FLETCHER, Proc. Linn. Soc. N. S. W., iv. (2), 1890, p. 990.

C. (?) fasciatus, FLETCHER, p. 988.

Fletcherodrilus unicus, MICHAELSEN, JB. Hamb. wiss. Anst., viii, 1891, p. 29.

Definition. *Length, up to 325 mm.; breadth, 10 mm.; number of segments, 159. Dorsal pores commence between IV/V. Gizzard in VI; three pairs of calciferous glands in XIII–XV. Clitellum, $\overline{\text{XIII–XVIII}}$. Sperm-sacs in segments IX–XII. Last pair of hearts in XII. Hab.—Queensland; N. S. Wales; Pelew Islands.*

Although MICHAELSEN stated that his *C. purpureus* agreed 'point for point' with FLETCHER'S *C. unicus*, the latter author retained the two species, adding to them a third species, *C. fasciatus*. After the publication of the paper in which FLETCHER distinguished the three species, MICHAELSEN again emphasized the real identity of the three; FLETCHER used as points of difference the stouter form of the body in the species '*fasciatus*,' and also mentioned that the setae are straight in '*fasciatus*,' while they are sinuous in '*purpureus*.' The irregularity of the setae, however, varies very much in individuals, and is, perhaps, therefore, hardly to be used as a specific character. Some worms from Percy Island, described by FLETCHER as '*incertae sedis*,' appear, according to his latest opinion, to be referable to this species. The examples from the Pelew Islands are much larger than the others. The additional pair of sperm-sacs described by FLETCHER, on the posterior face of the septum xii/xiii, are possibly egg-sacs (cf. *Perichaeta*, see p. 97).

Genus TRINEPHRUS, BEDDARD.

Syn. **Cryptodrilus**, FLETCHER, SPENCER (in part.).

DEFINITION. **Three pairs of nephridia in each segment. Spermiducal glands either lobate or tubular.**

This genus, like many others of the Cryptodrilidae, is by no means altogether satisfactory; but it represents the best that the facts at hand permit of. The presence of three distinct and separate pairs of nephridia in a single segment appears to me to be so remarkable a character that the species thus distinguished from other Cryptodrilidae deserve generic separation. It is, however, only by this character that they can be separated from other species of *Cryptodrilus* and *Megascolides*. If the two species, *fastigatus* and *dubius*, were the only two Cryptodrilidae that showed this arrangement of the nephridia, the genus would be much more easily definable; but *T. tenuis* and *T. mediocris*, particularly the latter, differ from those two in a good many particulars, as may be seen by an inspection of the table on p. 448. It may be convenient to recapitulate here in a tabular form the main characters of the four species which I here relegate to the genus *Trinephrus*.

	T. FASTIGATUS.	T. TENUIS.	T. MEDIOCRIS.	T. DUBIUS.
Prostomium	complete	complete	incomplete	complete
Dorsal pores. . . .	from iv/v	?	from xi/xii	from v/vi
Spermathecae . . .	two caeca	one caecum	one caecum	two caeca
Sperm-sacs	xi, xii	?	ix, xii	xi, xii
Spermiducal glands .	iv, tubular	ii, tubular	ii, lobate	iv, tubular

Unfortunately, the form of the spermiducal glands is not quite certain in the four species; SPENCER describes them as a 'coiled tubular mass,' but distinctly figures them as of the lobate kind. FLETCHER'S expression, 'incised glands,' applied to these organs in *T. mediocris*, seems to indicate that they are lobate. It will be seen, therefore, that *T. mediocris* differs from the three other species in having an incomplete prostomium, lobate spermiducal glands, and sperm-sacs in segments ix, xii; and that the three remaining species, as regards these characters, differ from *T. mediocris*, but agree with each other. The agreement between *T. fastigatus* and *T. dubius* is closest. It would be a relief to find that the nephridia of the species, which I call for the present *T. mediocris*, were not paired but diffuse. It will be noticed from the tables on p. 448 that the Cryptodrilidae, referred to the genera *Megascolides* and *Cryptodrilus* by FLETCHER and SPENCER, can be arranged in three parallel series under the two divisions of those with lobate, and those with tubular, spermiducal glands; in each group are worms with diffuse, paired and three-paired nephridia.

(1) Trinephrus fastigatus (Fletcher).

Cryptodrilus fastigatus, Fletcher, Proc. Linn. Soc. N. S. W. (2), iii, 1889, p. 1541.

Definition. *Length,* 89 *mm.; diameter,* 4 *mm.; number of segments,* 140. *Prostomium completely dividing buccal ring. Clitellum, XIV–XVII complete. Setae of outer couples further apart than of inner couples. Male pores opposite first seta; ventral surface of segment XVIII tumid. Oviduct pores in front and ventrad of seta I. Dorsal pores commence between IV/V. Gizzard in V; large intestine begins in XVIII. Sperm-sacs in XI, XII. Spermathecae in VIII, IX, with two caeca. Spermiducal glands four, two of each side unite before opening. Last hearts in XII. Hab.—Burrawang and Illawarra, N. S. Wales.*

Fletcher describes what appear to be egg-sacs in segments xiii and xiv. The spermiducal glands occupy respectively segments xviii and xix–xxi; the ducts of the two of each side unite to form a single duct which is bent upon itself; the sperm-duct joins the ducts of these glands just after their union. In one specimen the last pair of hearts was in segment xiii.

(2) Trinephrus tenuis (Fletcher).

Cryptodrilus tenuis, Fletcher, loc. cit., p. 1543.

Definition. *Length,* 90 *mm.; diameter,* 4 *mm.; number of segments,* 190. *Prostomium complete. Setae of outer couples further away than of inner. Male pores between setae of inner couples. Spermathecae with a single rather rudimentary caecum. Spermiducal glands single on each side and tubular. Hab.—Braidwood, N. S. W.*

This species is, owing to the immaturity of the examples, incompletely described by Fletcher; in addition to the points noticed in the above, he says that the dorsal pores commence further forward than in the last species; it also has a much paler colour.

(3) Trinephrus mediocris (Fletcher).

Cryptodrilus mediocris, Fletcher, loc. cit., p. 1544.

Definition. *Length,* 65 *mm.; diameter,* 3·5 *mm.; number of segments,* 125. *Prostomium does not divide buccal ring. Setae of outer couple further apart than of inner. Clitellum, XIII–XVII, complete. Male pores just dorsad of setae I; between X/XI a pair of papillae; similar pairs between XV/XVI, XVI/XVII, XIX/XX, XX/XXI; also a pair on XVII or XVIII. Dorsal pores commence XI/XII. Gizzard in V, intestine begins in*

XVI. Last pair of hearts in XII. Sperm-sacs in IX, XII; spermathecae in VIII, IX, with a single diverticulum. Hab.—Near Paramatta, Sydney.

(4) Trinephrus dubius (SPENCER).

Cryptodrilus dubius, SPENCER, P. R. Soc. Vict., 1891, p. 136.

Definition. *Length, 'three and a half inches'; diameter, 'less than a quarter inch.' Prostomium complete. Setae of outer couple further apart than of inner. Male pores ventral of level of setae 2. Paired papillae on XVII, median papilla on XVII/XVIII. Dorsal pores commence V/VI. Gizzard in V; calciferous glands in XV, XVI; intestine begins in XVIII. Sperm-sacs in XI, XII; spermathecae in VIII, IX, with two diverticula. Spermiducal glands two pairs as in* T. fastigatus. *Hab.—Victoria.*

SPENCER remarks that this species is to be distinguished from *T. fastigatus* by the possession of well-developed calciferous glands and by the sperm-sac not being racemose; the two are evidently very closely allied.

Genus DIGASTER, PERRIER.

Syn. **Perissogaster,** FLETCHER.
Didymogaster, FLETCHER.

DEFINITION. Prostomium incompletely divides buccal ring. Clitellum, XIII (XIV)-XVII (XVIII). Gizzards, two or three. Nephridia diffuse. Spermiducal glands lobate.

I have already given my reasons for associating the three genera *Digaster*, *Perissogaster*, and *Didymogaster* into one genus, which must obviously be called *Digaster*. As thus constituted the genus will contain seven species. It is, as I have already indicated, very close to *Cryptodrilus*.

The most remarkable species in the genus is perhaps *D. sylvaticus*, with its spirally-arranged intestine; this character is, however, found elsewhere among the terricilous Oligochaeta, for it has been described by BENHAM in *Plagiochaeta*. There are two other genera of Cryptodrilids nearly allied to the present which possess two gizzards; these are *Dichogaster* and *Microdrilus;* but the present genus differs from both of these in having the male pores upon the eighteenth segment instead of the seventeenth. The two genera mentioned have also tubular spermiducal glands. On these grounds chiefly, though there are also minor points of difference, I distinguish both of them from each other and from *Digaster*. The type species of *Digaster* is *D. lumbricoides*.

(1) Digaster lumbricoides (PERRIER).

D. lumbricoides, PERRIER, Nouv. Arch. Mus., 1872, p. 94.

Definition. *Clitellum, XIV–XVI. Male pores on XVII (?); a pair of papillae on segments in front of and behind that carrying male pores. Dorsal pores commence IV/V. Gizzards two in V, VII. Sperm-sacs in X, XI. Hab.—Port Macquarie, Australia.*

PERRIER'S description is not very exhaustive; and it is indeed not at all certain whether the species really belongs to the genus *Digaster* as here defined, in which case, of course, the name will have to be altered. He states, for instance, that the male pores are upon the seventeenth segment. Nothing is said with regard to the nephridia.

(2) Digaster queenslandica (FLETCHER).

Perissogaster Queenslandica, FLETCHER, Proc. Linn. Soc., N. S. W. (2), iii, 1889, p. 1529.

Definition. *Length,* 158 *mm.; diameter,* 8 *mm.; number of segments,* 220. *Prostomium incomplete. Setae of outer couples further apart than of inner, slightly sinuous. Male pores corresponding to interval between setae one and two. Dorsal pores commence III/IV. Gizzards three in V–VII; calciferous glands in XIV, XV. Last pair of hearts in XII. Sperm-sacs in XI, XII. Spermathecae in VIII, IX, with a rosette-like caecum. No penial setae. Hab.—Oxley, near Brisbane.*

FLETCHER speaks of the sperm-sacs as occupying segments xi–xiii; I think, however, that in all probability the last pair of reputed sperm-sacs are egg-sacs.

(3) Digaster perrieri, FLETCHER.

D. Perrieri, FLETCHER, loc. cit., p. 1530.

Definition. *Length,* 90 *mm.; diameter,* 5 *mm.; number of segments,* 155. *Prostomium incomplete. Clitellum, XIV–XVII complete. Setae of outer couples further apart than of inner. Dorsal pores commence X/XI. Papillae on X, XI or IX–XII, and XVII–XIX. Gizzards two. Sperm-sacs in XI, XII. Penial setae with serrated extremity. Hab.—Springwood, N. S. W.*

This species is compared by FLETCHER with *D. armifera;* and both are contrasted with *D. lumbricoides.* He says nothing about the spermathecae.

(4) Digaster excavata (Fletcher).

Perissogaster excavata, Fletcher, loc. cit., ii. (2), 1888, p. 383.

Definition. *Length, 334 mm.; breadth, 15 mm.; number of segments, 195. Prostomium incomplete. Clitellum, XIII–XVIII, complete except for three fossae in front of behind enclosing male pores. Setae in eight rows; those of outer couple further apart than inner. Oviducal pores 2 mm. apart. Dorsal pores absent. Gizzards, three in V–VII; no distinct calciferous glands; intestine begins in XVI, arranged in a spiral. Septa, VII/XIV, thickened. Last pair of hearts in XII. Sperm-sacs in IX, XII; sperm-reservoirs in X, XI. Spermathecae in VIII, IX, with bifid or trifid diverticulum, opening in line with seta 1. Hab.—Morpeth, Hawkesbury river, N. S. W.*

(5) Digaster nemoralis (Fletcher).

Perissogaster nemoralis, Fletcher, loc. cit., iii (2), 1889, p. 1527.

Definition. *Length, 130 mm.; breadth, 6 mm.; number of segments, 245. Prostomium incomplete. Setae in eight rows, outer couple further apart than inner. Clitellum, XIII–XVIII, complete, except where papillae occupy ventral space. Male pores in line with interval between setae one and two. Genital papillae, two pairs, between XVI/XVII, XVIII/XIX. Dorsal pores begin X/XI. Gizzards, three in V–VII; calciferous glands in X–XIV; intestine begins in XVII; it has a typhlosole. Last pair of hearts in XIII. Sperm-sacs in IX, XI, XII. Spermathecae in VIII, IX, with short diverticulum. Penial setae present. Peptonephridia in IV. Hab.—Gosford, N. S. W.*

(6) Digaster armifera, Fletcher.

D. armifera, Fletcher, loc. cit. i (2), 1887, p. 947.

Definition. *Length, 125 mm.; diameter, 5 mm.; number of segments, 205. Prostomium incomplete. Clitellum, XIV–XVII. Setae of outer couples further apart than of inner. Papillae a swollen ridge on XVII, XIX and XI, XII. Dorsal pores commence XII/XIII. Gizzards two in V, VI; intestine begins in XVII. Anterior nephridia modified into peptonephridia. Last hearts in XII. Anterior septa up to XII/XIII thickened. Sperm-sacs in XI, XII. Spermathecae in VIII, IX, with rudimentary caecum. Penial setae, extremity ornamented with circular serrated ridges. Hab.—Marrickville, near Sydney, Auburn, near Paramatta, N. S. W.*

With some doubt Fletcher refers some species from Percy Island to the same species. The characters of these were insufficiently defined to permit of certainty in the matter.

(7) Digaster sylvaticus (FLETCHER).

Didymogaster sylvaticus, FLETCHER, loc. cit., p. 554.

Definition. *Length,* 80 *mm.; diameter,* 12 *mm.; number of segments,* 120. *Prostomium incomplete. Clitellum, XIII–XVIII. Setae of outer row sinuous. Dorsal pores commence V/VI. Oviducal pores close to median line. Gizzards in VI, VII; intestine arranged in a corkscrew fashion. Last hearts in XIII; supraintestinal trunk double. Sperm-sacs in IX, XII; spermathecae in VIII, IX, with small pyriform caecum. Hab.—Burrawang, Springwood, Jervis Bay, N. S. W.*

FLETCHER mentions in this species in each of the four segments v–ix a pair of peculiar bodies on either side of oesophagus richly supplied with blood-vessels, but is unable to suggest their nature. There is evidently an inaccuracy with regard to the spermathecae somewhere, either in the description or figure; he describes them as lying in segments vii, ix, but seems to figure three pairs in vii, viii, ix.

Genus MEGASCOLIDES, McCOY.

Syn. **Cryptodrilus,** FLETCHER, et alii (in part.).
Plutellus, BENHAM (? *non* PERRIER).

DEFINITION. Nephridia paired. Spermiducal glands in XVIII, tubular in form.

As has already been pointed out there are no differences of importance which serve to distinguish *Plutellus* from *Megascolides.* The wide separation in range is the only reason indeed which could possibly, in my opinion, lead to their generic separation; and this, be it observed, is curiously paralleled by the Marsupials. This being the case, the name *Megascolides* ought to be dropped in favour of *Plutellus;* but I do not consider it to be yet proved that BENHAM'S *P. perrieri* is congeneric with PERRIER'S *P. heteroporus.* The latter species has been stated to possess ovaries which are situated in front of the testes. This is, of course, if true, a unique case; so too is its other distinguishing feature, viz. the fact that the nephridia are confined to one segment, the funnel not lying, as is elsewhere invariably the arrangement, in front of the septum. No doubt many naturalists have thrown doubts upon PERRIER'S statements concerning these two important points, and it must be admitted that they seem from our present knowledge to be improbable; nevertheless, no great harm will be done if we leave the matter for further proof, and regard the genus *Plutellus* as '*incertae sedis.*' BENHAM'S species will be treated as a *Megascolides.*

The species are here grouped according to the number of spermathecae and sperm-sacs. It is noteworthy that only one of the species which has only a single pair

of sperm-sacs has also only a single pair of testes. In the allied *Cryptodrilus* one pair of sperm-sacs almost always means one pair of testes.

Spermathecae in viii, ix.	**M. narrensis**	
	M. lucasi	
	M. incertus	Sperm-sacs in ix, xii.
	M. attenuatus	
	M. tuberculatus	
	M. roseus	
	M. minor	
	M. intermedius	Sperm-sacs in xii.
	M. sinuosus	
	M. semicinctus	
	M. australis	Sperm-sacs in xi–xiv.
	M. ornatus	
	M. papillifer	Sperm-sacs in x–xii.
	M. orthostichon	
Spermathecae in v–ix.	**M. victoriae**	
	M. tasmanianus	Sperm-sacs in ix–xii.
	M. willsiensis	
	M. tanjilensis	Sperm-sacs in xii.
	M. frenchi	Sperm-sacs in ix, x.
	M. gippslandicus	
Spermathecae in vii, viii.	**M. manni**	
Spermathecae in vi–ix.	**M. macedonensis**	Sperm-sacs in xii.
	M. perrieri	
	M. smithi	Sperm-sacs in ix, xii.
Spermathecae ?	**M. rubens**	Sperm-sacs in xii.

(1) Megascolides victoriae (Spencer).

Cryptodrilus victoriae, Spencer, P. R. Soc. Vict., 1892, p. 139.

Definition. *Length,* 100 *mm.; breadth,* 10 *mm. Clitellum, XIV–XVI (or XIII–XVII). Setae irregular, at extreme end of body. Dorsal pores commence III/IV. Male pores slightly dorsal to level of setae one. Genital papillae: a ventral patch on IX–XI; three pairs on XVI/XVII, XVII/XVIII, XVIII/XIX, the middle pair being to outside of the others. Gizzard in V; no calciferous glands; intestine begins in XVII. Sperm-sacs in IX, XII; spermathecae in V–IX, with diverticulum one-third of length of pouch. Hab.—Warburton, Yarra Valley.*

SPENCER describes two varieties of this species which appear to be rather smaller; they also differ in the presence of a 'curious elongate white smooth surface' extending from segment xvii–xxiii[1], and sometimes also on segments iv–ix. The spermathecal pores are slightly dorsal of the third seta, and have either a longer or a much shorter duct.

(2) Megascolides narrensis (SPENCER).

Cryptodrilus narrensis, SPENCER, loc. cit., p. 142.

Definition. *Length*, 40 *mm.; breadth*, 3 *mm. Clitellum XIII–XVIII, complete. Setae, outer further apart than inner; towards posterior end of body rows gradually separate until the fourth becomes dorsal in position. Male pores on level with interval between two setae on inner pair. Oviducal pores in front of and ventral to inner seta. Genital papillae two, one on XVII the other on XVIII/XIX. Gizzard in V; no calciferous glands; intestine begins in XX. Sperm-sacs in IX, XII. Spermathecae in VIII, IX, diverticulum one-third. Hab.—Narre Warren, Gippsland.*

(3) Megascolides lucasi (SPENCER).

Cryptodrilus lucasi, SPENCER, loc. cit., p. 143.

Definition. *Length*, 110 *mm.; breadth*, 3–4 *mm. Clitellum XIII–XVIII, complete except on XVII, XVIII. Setae all close to ventral surface; outer rows irregular posteriorly. Male pores between setae one and two. Oviducal pores slightly anterior to and ventral of the inner seta. Dorsal pores commence IV/V. Gizzard in V; no glands; intestine begins in XV. Sperm-sac in IX, XII; spermathecae in VIII, IX, rosette-shaped diverticulum. Hab.—Tallarook, Goulburn River.*

This species is stated by SPENCER occasionally to possess an additional pair of ovaries in xiv; he figures also a second pair of oviducts in xii.

(4) Megascolides minor (SPENCER).

Cryptodrilus minor, SPENCER, loc. cit., p. 144.

Definition. *Length*, 100 *mm.; 'very narrow.' Prostomium incomplete. Clitellum, XIV–XVIII. Male pores on level with interval between setae* 1 *and* 2. *Setae become irregular at end of body; anteriorly strictly paired. Oviducal pores anterior to and ventral of the inner seta. Dorsal pores commence behind clitellum. Genital papillae, two elliptical patches*

[1] Compare (perhaps) *Eudriloides* (below).

on XVII, XIX. Gizzard in V; no calciferous glands. Intestine begins in XX. Testes one pair (in XI). Sperm-sac in XII. Spermathecae in VIII, IX. Diverticulum trifid. Hab.—S. Warragul, Gippsland.

(5) Megascolides manni, Spencer.

M. manni, Spencer, loc. cit., p. 149.

Definition. *Length, 250 mm.; breadth, 6 mm. Prostomium incomplete. Clitellum, XIV–XVIII, complete. Setae of outer couple slightly further apart than those of inner. Male pores slightly ventral of level of inner seta. Oviducal pores ventral of level of inner seta. Genital papillae single on XVII/XVIII, XVIII/XIX. Dorsal pores begin behind clitellum. Gizzard in V, VI; no calciferous glands. Intestine begins in XVIII. Sperm-sacs in XI, XII; spermathecae in VII, VIII, small round diverticulum. Hab.—S. Warragul, Gippsland.*

Of this worm a variety is described which has circular instead of club-shaped genital papillae. Spencer mentions tufts of nephridial tubes in v–vii.

(6) Megascolides incertus, Spencer.

M. incertus, Spencer, loc. cit., p. 151.

Definition. *Length, 250 mm.; breadth, 6 mm. Clitellum, XIII–XVIII. Prostomium complete. Setae of outer couple twice as far away as those of inner. Male pores on level with interval between setae 1 and 2. Oviducal pores anterior to and ventral of inner setae. Genital papillae on XVI/XVII, XIX/XXIII, the latter series getting smaller from before backwards. Gizzard in VI; no calciferous glands, not even swellings of oesophagus; intestine begins in XVIII. Sperm-sacs in IX, XI; spermathecae in VIII, IX; diverticulum minute. Hab.—Victoria (? exact locality).*

(7) Megascolides sinuosus, Spencer.

M. sinuosus, Spencer, loc. cit., p. 152.

Definition. *Length, 500 mm.; breadth, 7 mm. Prostomium incomplete. Clitellum ? Setae of outer couple far apart; outer rows sinuous in middle and end of body. Oviducal pores anterior to and ventral of inner setae. Genital papillae single on XIX/XX, XX/XXI. Gizzard in V; vascular swellings in 13–17; intestine begins in XVIII. Last heart in XIII. Excretory system diffuse. Sperm-sacs in XII; spermathecae VIII, IX, with short diverticulum. Hab.—Dandenong Ranges.*

(8) Megascolides roseus, Spencer.

M. roseus, Spencer, loc. cit., p. 153.

Definition. *Length, 175 mm.; breadth, 6 mm. Prostomium complete. Clitellum complete, XIII–XVIII; saddle-shaped in XVI–XVIII. Setae of each couple close together anteriorly behind, further away. Male pores on a level with interval between two setae on inner pair. Oviducal pores ventral of and anterior to innermost seta. Genital papillae: one between male pores, a pair on XVII, four pairs on XIX/XXIII, getting to be closer together behind. Dorsal pores commence behind clitellum. Gizzard in V; calciferous glands in XV, XVI; intestine begins in XVIII. Sperm-sacs in XII; spermathecae VIII, IX, rosette-shaped diverticulum. Hab.—Warragul.*

(9) Megascolides attenuatus, Spencer.

M. attenuatus, Spencer, loc. cit., p. 155.

Definition. *Length, 200 mm.; breadth, 1–3 mm. Prostomium incomplete. Clitellum, XIII–XVIII. Setae of outer couple slightly further apart than ventral. Fourth row irregular in last ten segments. Oviducal pores in front of ventral of inner seta. Dorsal pores commence V/VI. Gizzard in V; no calciferous glands. Sperm-sacs in IX, XII; spermathecae VIII, IX, with small diverticulum. Hab.—Warragul.*

Spencer mentions that there are numerous minute grape-like processes round spermiducal glands; these may be glands such as occur in this situation in *Perichaeta.*

(10) Megascolides rubens (Fletcher).

Cryptodrilus rubens, Fletcher, Proc. Linn. Soc. N. S. W., ii (2), 1888, p. 381.

Definition. *Length, 55 mm.; breadth, 4 mm.; number of segments,* 114. *Prostomium incomplete. Clitellum, XIV–XVI, complete. Setae in eight rows; ventral closer together. Male pores in line with second seta; in front of and behind each a small papilla, through one of which protrude (?) penial setae. Dorsal pores absent. Calciferous glands in X–XIII; intestine begins in XVI. Last hearts in XII. Sperm-sacs in XII only, but two pairs of funnels. Spermathecae (?). Penial setae present. Hab.—Mount Wilson.*

Fletcher remarks that in segments vi and vii is a thin walled globular portion of oesophagus, both of which may be gizzards.

(11) Megascolides tasmanianus (Fletcher).

Notoscolex tasmanianus, Fletcher, loc. cit., p. 607.

Definition. *Length, 570 mm.; breadth, 12 mm.; number of segments, about 200. Prostomium incomplete. Clitellum, XIII–XXII. Setae in eight rows, the outer row further back, the other row generally sinuous. Male pores on interval between setae 1 and 2. Oviducal pores to inside of inner seta. Dorsal pores commence between segments XII/XIII. Gizzard in V; no separate calciferous glands; intestine begins about XIX. Last heart in XIII. Septa, V/XIII, thickened. Sperm-sacs in IX, XII; spermathecae without caeca in V–IX. Hab.—N. E. Tasmania.*

(12) Megascolides gippslandicus (Spencer).

Cryptodrilus gippslandicus, Spencer, P. R. Soc. Vict., 1892, p. 132.

Definition. *Prostomium complete. Clitellum, XIII–XVII, only developed dorsally. Setae anteriorly in couples, posteriorly irregular. Male pores on level with interval between two inner setae. Oviducal pores ventral of and anterior to innermost seta. Dorsal pores commence III/IV. Gizzard in V; calciferous glands in XIV, XV; intestine begins in XVII. Dorsal vessel double from segment VI to near end of body. Sperm-sacs in IX, X; spermathecae in V–IX; diverticulum one-quarter length of sac simple. Hab.—Croajingolong, East Gippsland.*

(13) Megascolides intermedius (Spencer).

Cryptodrilus intermedius, Spencer, loc. cit., p. 133.

Definition. *Length, 175 mm.; breadth, 6 mm. Prostomium incomplete. Clitellum, XIV–XVIII. Setae in couples except at very posterior end, where outer irregular. Male pores on level of first seta. Oviducal pores ventral of and anterior to first seta. Dorsal pores commence V/VI. Gizzard in V; no separate calciferous glands; intestine begins in XIX. Last heart in XIII. Testes one pair. Sperm-sacs attached to anterior wall of XII. Spermathecae in VIII, IX; small rosette-like diverticulum. Hab.—S. Warragul, Gippsland.*

This species is stated by Spencer to have a second pair of sperm-sacs in xiv; these must surely be the egg-sacs.

(14) Megascolides tanjilensis (SPENCER).

Cryptodrilus tanjilensis, SPENCER, loc. cit., p. 134.

Definition. *Length,* 137 *mm.; breadth,* 12 *mm. Prostomium complete. Clitellum complete, XIII–XVII. Setae with outer couple wider apart than inner. Male pores in line with interval between setae* 1 *and* 2. *Oviducal pores ventral of and anterior to seta* 1. *Genital papillae on XVI, XVIII/XIX on level with innermost seta; on XVII/XVIII considerably to outside of this. Gizzard in V; no calciferous glands; intestine begins in XVIII. Sperm-sacs in XII. Spermathecae in V–IX; diverticulum, one-quarter of length of pouch, simple. Hab.—Tanjil track, near source of Yarra.*

(15) Megascolides frenchi (SPENCER).

Cryptodrilus frenchi, SPENCER, loc. cit., p. 135.

Definition. *Length,* 75 *mm.; breadth,* 3 *mm. Prostomium incomplete. Clitellum, XIV–XVI, 'not very distinctly marked ventrally.' Setae irregular posteriorly; inner closer than outer. Male pores on level with interval between setae* 1 *and* 2. *Oviducal pores ventral to inner setae. Genital papillae: on X, XI, XVI/XXI, on level with interval between setae* 1/2. *Dorsal pores commence IV/V. Gizzard in VI; no calciferous glands. Sperm-sacs on anterior wall of X, posterior wall of IX. Spermathecae in V–IX; diverticulum one-third length of sac. Hab.—Croajingolong, East Gippsland.*

(16) Megascolides macedonensis (SPENCER).

Cryptodrilus macedonensis, SPENCER, loc. cit., p. 138.

Definition. *Length,* 75 *mm.; breadth,* 3 *mm. Prostomium incomplete. Clitellum, XIV–XVII, complete. Setae with greater distance between two setae of dorsal couple. Male pores in line with interval between setae* 1 *and* 2. *Oviducal pores anterior to and ventral of inner seta. Genital papillae large, covering ventral surface of the segments, on IX/X, X/XI, XVII/XXI. Dorsal pores commence IV/V. Gizzard in V; no calciferous glands; intestine begins in XVIII. Sperm-sacs in XII; spermathecae in VI–IX, with small diverticulum. Hab.—Mount Macedon, Victoria.*

(17) Megascolides willsiensis (SPENCER).

Cryptodrilus willsiensis, SPENCER, loc. cit., p. 140.

Definition. *Length,* 187 *mm.; breadth,* 12 *mm. Clitellum, XIV–XVII. Setae of outer*

pair much further apart than ventral, irregular posteriorly. Male pores on level with interval between two rows of ventral setae. Gizzard in V; no calciferous glands; intestine begins in XVIII. Dorsal vessel double from segment V. Sperm-sacs in IX (posterior wall) and XII (anterior wall). Spermathecae in V–IX, each with two diverticula. Hab.—Mount Wills.

This species has occasionally as many as five setae on each side of posterior segments.

(18) Megascolides smithi (Fletcher).

Cryptodrilus Smithi, Fletcher, Proc. Linn. Soc., N. S. W., iv (2), 1890, p. 992.

Definition. *Length,* 145 *mm.; breadth,* 3 *mm.; number of segments,* 170. *Prostomium incomplete. Clitellum, XIV–XVII, complete. Setae, four couples, separated by an unusually wide interval; setae of dorsal pair further away than those of ventral. Oviducal pores in front and a little ventrad of first seta. Genital papillae, a pair on groove between each of segments XV/XX. Dorsal pores commence IV/V. Gizzard in V (or VI); no distinct calciferous glands; intestine in XVIII. Sperm-sacs in IX, XII. Last pair of hearts in XII. Spermathecae in VI–IX, with small diverticulum opening in line with oviducal pores. Hab.—Eltham, Victoria.*

(19) Megascolides tuberculatus (Fletcher).

Notoscolex tuberculatus, Fletcher, loc. cit., ii (2), 1888, p. 611.

Definition. *Length,* 350 *mm.; breadth,* 7 *mm.; number of segments,* 280. *Prostomium incomplete. Clitellum, XIII–XVIII. Setae in eight rows, the outer a little further apart than the inner. Male pores in line with interval between ventral setae. Oviducal pores in front of and ventrad of first seta. Genital papillae represented by a 'dumb-bell-shaped fossa' on segments XVII–XXII. Dorsal pores commence XII/XIII. Gizzard in V; separate calciferous glands absent; intestine begins in XVIII; salivary glands (? nephridial) in V, VI. Septa VII/XIII thickened. Last hearts in XII. Sperm-sacs in IX, XII. Spermathecae in VIII, IX, each with a minute caecum. Penial setae present. Hab.—Gippsland, Victoria.*

Fletcher remarks of this species that it is extremely slender.

(20) Megascolides semicinctus (Fletcher).

Cryptodrilus semicinctus, Fletcher, loc. cit., iv (2), 1890, p. 996.

Definition. *Length,* 54 *mm.; breadth,* 3 *mm.; number of segments, about* 100. *Prostomium*

incomplete. Clitellum, $\overline{XIII}$–XVII, saddle-shaped. Setae of outer couples further apart than inner. Male pores in line with seta 2. Oviducal pores in front of, and ventrad of, inner seta. Genital papillae, one in front and one behind, and rather dorsal of, each male pore; intersegmental in position. Dorsal pores commence XVIII/XIX. Gizzard in V; no distinct calciferous glands; intestine begins in XVI. Testes and funnels, one pair only; sperm-sacs in XII. Spermathecae in VIII, IX, each with two (or three) caeca. Last hearts in XII. Penial setae present. Hab.—Grafton, Clarence River, N. S. Wales.

(21) Megascolides ornatus (Eisen).

Argilophilus marmoratus ornatus, Eisen, Zoe, iv, p. 253.

Definition. *Length, about 150 mm. Clitellum, XIII–XVIII. Genital papillae paired on VIII/X, XV/XVII, XIX/XX, intersegmental; ventral setae closer together than lateral. No calciferous glands. Last hearts in XIV. Spermathecae in VIII, IX. Sperm-sacs in X–XII. Nephridia without terminal vesicle, alternate in position. Penial setae ornamented with spines. Hab.—San Francisco to Oregon.*

This and the following species (regarded by Eisen as subspecies or varieties) were placed by him in a distinct genus, *Argilophilus.* There does not, however, appear to me to be any good grounds for placing them in a genus apart from *Megascolides.* Their anatomy is described in the most detailed fashion in a subsequent memoir **(16)**.

(22) Megascolides papillifer (Eisen).

Argilophilus marmoratus papillifer, Eisen, loc. cit., p. 253.

Definition. *Like the last species, but genital papillae median, intersegmental, one to seven in number. Hab.—San Francisco and southwards.*

(23) Megascolides australis, McCoy.

M. australis, McCoy, Prodr. Zool. Vict. Dec. 1, 1878.

Notoscolex gippslandicus, Fletcher, Proc. Linn. Soc. N. S. W., ii (2), 1888, p. 603.

Definition. *Length, 1·23 m.; diameter, 17 mm.; number of segments, 500. Prostomium incomplete. Clitellum, $\overline{XIII}$–XXI. Setae of outer pair further apart than of inner. Male pores occupy position of ventral pair of setae which are absent. Papillae median on XVII/XVIII, XVIII/XIX, and XIX/XX; the middle papilla carries the male pores, and is more extensive than the others. Dorsal pores commence XV/XVI. Gizzard in V; intestine begins in XIX. Septa IV/XIV thickened. Last hearts in XIII. Nephridia*

diffuse, with larger paired tubes posteriorly. Sperm-sacs in XI–XIV on posterior septum. Spermathecae in VIII–IX, with rosette-like caecum. Hab.—Gippsland, Victoria.

The reason for FLETCHER placing his species in a different species from McCOY'S was chiefly the inaccurate description given by the latter. It is not, however, clear why FLETCHER should have considered it right to give a new generic name to his species, for the differences which he enumerates are hardly so important as would warrant this course. In any case the description given by FLETCHER is confirmed in almost every particular by SPENCER (**1**), and the species is the best known of all the members of the genera *Cryptodrilus* and *Megascolides*. I deal elsewhere with such anatomical points as are of more than specific importance. The most remarkable feature in its organization is, in many respects, the extraordinary extension of the sperm-sacs; it is, of course, possible that the two pairs of the thirteenth and fourteenth segments are really egg-sacs; but their large size is against this supposition, and SPENCER distinctly speaks of sperm in their interior. The dorsal blood-vessel is enclosed in a sac which gives off lateral diverticula filled with corpuscles; *Deinodrilus* is the only other earthworm in which the dorsal vessel is thus enclosed in a pericardium.

The development of the nephridia has been studied by VEJDOVSKY (**4**).

(24) Megascolides orthostichon (SCHMARDA).

Hypogaeon orthostichon, SCHMARDA, Neue wirbell. Th. I. ii (1861), p. 12.
M. orthostichon, BEDDARD, Ann. Mag. Nat. Hist. Feb., 1892, p. 130.

Definition. *Length,* 180 *mm.; number of segments,* 65. *Clitellum, XIV–XVII, complete. Setae in eight equidistant rows. Male pores correspond to ventral setae, which are wanting. No genital papillae. Gizzard in V. Nephridia diffuse. Sperm-sacs in X–XII. Spermathecae in VIII, IX, with pyriform caecum. Hab.—New Zealand.*

This species is chiefly interesting on account of the fact that it occurs in New Zealand, which is, unlike Australia, not inhabited by many Cryptodrilids; unfortunately, my description of its structure is far from being complete, owing to the fact that I had only the type of SCHMARDA, which it was necessary to respect. Hence the definition of this worm is not so satisfactory; it appears, however, to be distinct from any other species of the genus.

(25) Megascolides perrieri (BENHAM).

Plutellus perrieri, BENHAM, P. Z. S., 1892, p. 138.

Definition. *Length,* 50 *mm.; diameter,* 4 *mm.; number of segments,* 126. *Prostomium*

complete. Clitellum, XIII–XVIII. Setae distant, ventral closer to each other than dorsal. Male pores between setae 1 *and* 2. *No genital papillae. No dorsal pores. Gizzard in V; no calciferous glands; intestine begins in XVII. Nephridia paired, alternate. Testes in X. Sperm-sacs in XII. Spermathecae in VI–IX, without diverticula. Hab.—Queen Charlotte's Island, British Columbia.*

The anatomy of this species is fully illustrated by BENHAM.

Genus CRYPTODRILUS, FLETCHER.

Syn. **Megascolides,** SPENCER (in part.).

DEFINITION. Nephridia usually diffuse. Last pair of hearts in XII. Spermiducal glands lobate, rarely furnished with penial setae. Male pores upon XVIII.

I have already stated the reasons which lead me to divide somewhat differently from either FLETCHER or SPENCER the total of the species which those authors refer to the two genera *Cryptodrilus* and *Megascolides.* It appears to me, after consideration of the various structural features which characterise the family Cryptodrilidae, that the form of the spermiducal glands is rather more important than the variations offered by any other organs. The genus *Cryptodrilus* as defined here contains species with, and species without, a diffuse nephridial system. It might be held that these species should be referred to different genera; but it is not possible in the present state of our knowledge to discover from the descriptions any other characters which vary coincidently with the nephridia. There are, in fact, only seven species of *Cryptodrilus* which possess paired nephridia. It is highly possible that *Cryptodrilus canaliculatus* may not be a *Cryptodrilus* in the sense that the genus is here defined; but as no information about the spermiducal glands is to be found in FLETCHER'S account of the species it is impossible to be certain. For the present, therefore, and it must be understood that I lay no claim to have devised anything like a permanent arrangement, I shall include within this genus *Cryptodrilus* all the remaining Cryptodrilids with lobate spermiducal glands opening on to segment xviii.

In the accompanying table the species are arranged according to the spermathecae and sperm-sacs, which will perhaps facilitate their identification. In the six species with only one pair of sperm-sacs there are generally, but not always, only one pair of testes and funnels.

Spermathecae in viii, ix.	**C. victoriensis**	
	C. obscurus	
	C. hulmei	
	C. insignis	Sperm-sacs in xii.
	C. singularis	
	C. illawarrae	
	C. mudgeanus	
	C. simulans	
	C. saccarius	Sperm-sacs in xi, xii.
	C. pygmaeus	
	C. camdenensis	
	C. dubius	
	C. gravidis	Sperm-sacs in ix, xii.
	C. rusticus	
Spermathecae in v–ix.	**C. cameroni**	
Spermathecae in vii–ix.	**C. mediterreus**	
	C. canaliculatus	
	C. sloanei	
	C. tryoni	Nephridia paired.
Spermathecae in vi–ix.	**C. manifestus**	
	C. fletcheri	

(a) *With paired nephridia.*

(1) Cryptodrilus mediterreus, Fletcher.

C. mediterreus, Fletcher, Proc. Linn. Soc. N. S. W., ii (2), 1888, p. 614.

Definition. *Length,* 110 *mm.; diameter,* 5 *mm.; number of segments,* 150. *Prostomium incomplete. Clitellum, XIII–XVII, complete. Setae of outer couples further apart than of inner. Male pores dorsad of setae 2; median papillae on VI–IX, a pair on X, XI, and on anterior margin of XVIII, XIX, ventrad of male pores. Dorsal pores commence V/VI. Gizzard in V; calciferous glands in X–XIII; intestine begins in XVIII. Nephridia paired and alternate. Last hearts in XIII. Septa, VI/XIII, thickened. Sperm-sacs in XI, XII; spermathecae, VII–IX, caecum minute. Penial setae present, with serrated extremity. Hab.—Darling river, N. S. W.*

This species differs from the remaining forms which are associated with it by the character of their nephridia in having penial setae and in having sperm-sacs in x, xii, instead of ix, xii.

(2) Cryptodrilus canaliculatus, Fletcher.

C. canaliculatus, Fletcher, loc. cit., iii (2), 1889, p. 1534.

Definition. *Length*, 250 *mm.; diameter*, 5·5 *mm.; number of segments*, 265. *Prostomium incomplete. Clitellum, XIII–XVIII, complete. Setae of outer couples widely separated. Male pores on papillae preceded and followed on the same segment by similar papilla, of which there are also a pair on the next segment. Dorsal pores commence VIII/IX. Gizzard in V; calciferous glands in X–XIII, lying below the gut; intestine begins in XVI. Nephridia, paired, alternate. Sperm-sacs in IX, XII; spermathecae in VII–IX, caeca* 2. *Penial setae present. Hab.—Forbes, N. S. W.*

(3) Cryptodrilus sloanei, Fletcher.

C. Sloanei, Fletcher, loc. cit., p. 1536.

Definition. *Length*, 71 *mm.; diameter*, 5 *mm.; number of segments*, 150. *Prostomium nearly complete. Three pairs of calciferous glands in XI, XIII, lying below gut. Last hearts in XIII. Sperm-sacs in IX, XII; spermathecae three pairs, caeca* 2. *Hab.—Coonabarabran, N. S. W.*

It is not stated in so many words that this species has paired alternating nephridia; I infer, however, from its location in the neighbourhood of *C. canaliculatus*, and its comparison with this species and with *C. mediterreus*, that the nephridia are of that kind.

(4) Cryptodrilus manifestus, Fletcher.

C. manifestus, Fletcher, loc. cit., p. 1538.

Definition. *Length*, 70 *mm.; diameter*, 5·7 *mm.; number of segments*, 190. *Prostomium complete. Clitellum, XIV–XVII, complete. Setae of outer couples further apart than of inner. Male pores ventrad of innermost setae (which appear to be absent?); on XVII, XIX, and next three or four segments, papillae. First dorsal pore, VIII/IX. Gizzard in V; calciferous glands in X–XIII; intestine begins in XVI. Nephridia, paired, alternate. Last hearts in XII. Sperm-sacs in IX, XII; spermathecae in VI–IX, with a single caecum. Hab.—Waterfall, Bulli, National Park, N. S. W.*

This species is very near to *C. fletcheri*, but is distinguished by having four instead of two or three pairs of calciferous glands.

(5) **Cryptodrilus fletcheri,** BEDDARD.

C. fletcheri, BEDDARD, P. Z. S., 1887, p. 544.

? **C. Oxleyensis,** FLETCHER, Proc. Linn. Soc., N. S. W., iii (2), 1889, p. 1537.

Definition. *Clitellum, XIII–XVII, complete except on XVII. Setae in eight rows, the outer further apart than inner. Male pores on papillae, of which there are also pairs on XVIII, XIX–XXI. Oviducal pore a single 'slit-like orifice.' Gizzard in VI, VII; calciferous glands in XI, XII, ventral in opposition. Nephridia paired alternate. Sperm-sacs in IX, XII; spermathecae in VI–IX, with longish caecum. Hab.—Queensland.*

This species may or may not be identical with *C. oxleyensis*. There is nothing in FLETCHER'S description of the latter to militate against their identification; but his description is incomplete owing to the immaturity of the worms, as is mine in certain points, which ought to have been noticed and recorded. The dorsal pores in *C. oxleyensis* begin vi/vii. There are three pairs of calciferous glands ventral in position (I figure three but only describe two).

(6) **Cryptodrilus tryoni,** FLETCHER.

C. Tryoni, FLETCHER, Proc. Linn. Soc., N. S. W., iv (2), 1890, p. 994.

Definition. *Length, 325 mm.; diameter, 10 mm.; number of segments, 209. Prostomium incomplete. Clitellum, XIV–XVIII, complete except on ventral surface of XVII. Setae of outer rows remarkably far apart. Gizzard in V; calciferous glands in IX–XIII. Nephridia alternate; last hearts in XIII; septa, VI/XIV, thickened. Sperm-sacs in IX, XII; spermathecae three pairs, caeca two. Penial setae present. Hab.—Milton, near Brisbane.*

(b) *With diffuse nephridia.*

(7) **Cryptodrilus victoriensis** (SPENCER).

Megascolides victoriensis, SPENCER, P. R. Soc. Vict., 1892, p. 151.

Definition. *Length, 3 feet; breadth, 12 mm.; Prostomium incomplete. Clitellum, XIII–XIV. Setae of outer rows four times as far away from each other as those on inner, irregular at end of body. Male pores on level of interval 1/2. Genital papillae median on XIII/XIV, XIX/XXII; in all four. Dorsal pores commence XI/XII. Gizzard in V; no calciferous glands; intestine begins in XVII. Sperm-sacs in XII; spermathecae, VIII, IX, two rosette-like diverticula. Hab.—Victoria (? as to exact locality).*

(8) Cryptodrilus obscurus (Spencer).

Megascolides obscurus, Spencer, loc. cit., p. 148.

Definition. *Length, 425 mm.; breadth, 12 mm. Prostomium incomplete. Clitellum, XIII–XIX. Male pores on a level with interval between setae 1/2. Genital papillae median unpaired, XIII/XIV, XIX/XX, XX/XXI. Dorsal pores commence V/VI. Gizzard in VI; no calciferous glands, but swellings in XIII–XV. Intestine begins in XVIII. Sperm-sacs in XII; spermathecae in VIII, IX, each with two small diverticula. Hab.— Dandenong Ranges.*

The testes are only one pair in xi; but there are two pairs of funnels, those of x smaller.

(9) Cryptodrilus hulmei (Spencer).

Megascolides hulmei, Spencer, loc. cit., p. 147.

Definition. *Length (of an incomplete specimen), 3 ft. 5 in.; breadth, 6 mm. Prostomium incomplete. Clitellum, XIII–XX. Setae of outer couples slightly further apart than those of inner. Genital papillae unpaired; on XIII/XIV, XVI, XVII, XIX/XXII. Dorsal pores commence VIII/IX. Gizzard in V; no calciferous glands; intestine in XVII. Sperm-sacs in XII; spermathecae in VIII, IX, with small diverticulum. Hab.—Dandenong Ranges.*

Here again there is only one pair of testes in xi, but two pairs of funnels.

(10) Cryptodrilus insignis (Spencer).

Megascolides insignis, Spencer, loc. cit., p. 146.

Definition. *Length, 150 mm.; breadth, 6 mm. Clitellum, saddle-shaped, XIII–XVIII. Setae of outer rows further apart than those of inner. Posteriorly wider still. Male pores on interval between setae 1/2. Oviducal pores ventral of, and anterior to innermost setae. Genital papillae white swollen ridges ventrally on XV–XXI. Dorsal pores commence IX/X. Gizzard in VI; vascular swellings in X, XI; small diverticula in XII–XIV; large calciferous glands in XV–XVII; intestine begins in XIX. Testes and funnels one pair in XI. Sperm-sacs in XII; spermathecae in VIII, IX, with short diverticulum. Hab.—Dandenong Ranges.*

(11) Cryptodrilus cameroni (SPENCER).

Megascolides cameroni, SPENCER, loc. cit., p. 144.

Definition. *Length, 212 mm.; breadth, 12 mm. Prostomium incomplete. Clitellum, XVI–XXI incomplete, ventral at anterior end. Setae of outer couples further apart than of inner outer setae, irregular on clitellum. Male pores on level of innermost seta. Dorsal pores commence III/IV. Gizzard in V/VI; swellings of oesophagus in VIII–XIV; intestine begins in XIX. Dorsal vessel double as far as fifth segment, and to end of body. Sperm-sacs in IX, XII; spermathecae in V–IX, with diverticulum half the length of sac. Hab.—Croajingolong.*

(12) Cryptodrilus singularis, FLETCHER.

C. singularis, FLETCHER, Proc. Linn. Soc, N. S. W., iii (2), 1889, p. 1547.

Definition. *Length, 130 mm.; breadth, 7 mm.; number of segments, 240. Prostomium incomplete. Clitellum, XIII–XVIII, complete. Setae of outer couple further apart than inner. Male pores in line with seta 2. Oviducal pores in front of and ventrad of seta 1. Genital papillae elliptical areas between XVI/XXI. Dorsal pores commence XI/XII. Gizzard in V; no distinct calciferous glands; intestine begins in XVIII. Last pair of hearts in XII. Septa V/XII thickened. Testes and funnels one pair in XI; sperm-sacs in XII. Spermathecae in VIII, IX, with small diverticulum. Hab.—Burrawang, N. S. W.*

Four conspicuous ridge-like folds are described as existing on the floor of the intestine from segment xx–l; there is no typhlosole.

(13) Cryptodrilus saccarius, FLETCHER.

C. saccarius, FLETCHER, loc. cit., i (2), 1887, p. 951.

Definition. *Length, 195 mm.; breadth, 12 mm.; number of segments, 290. Prostomium incomplete. Clitellum, XIII–XVII, complete. Setae in eight rows more or less irregular, inner couple absent on XVIII. Male pores in line with interval between setae 1 and 2. Genital papillae vary; there may be two elliptical papillae between XI/XII and four between XVIII/XIX, and XX/XXIV. Oviducal pores in front of, and ventrad of first seta. Dorsal pores commence X/XI. Gizzard in V; calciferous glands in IX–XIII; salivary glands in V, VI; intestine begins in XV. Sperm-sacs in XI, XII. Spermathecae in VIII, IX, with small caecum opening dorsal of inner seta. Last hearts in XIII. Hab.—Hornsby, Port Jackson, Springwood, N. S. W.*

FLETCHER describes 'three' varieties of this—two in addition to the typical form; the latter are named respectively '*montanus*' and '*robustus*'; both of these differ in having an additional pair of calciferous glands in viii. They differ also in genital papillae and in size.

(14) Cryptodrilus mudgeanus, FLETCHER.

C. Mudgeanus, FLETCHER, loc. cit., iii (2), 1889, p. 1532.

Definition. *Length,* 58 *mm.; breadth,* 5·5 *mm.; number of segments,* 145. *Prostomium incomplete. Clitellum, XIII–XVIII, complete. Male pores just dorsad of first seta. Oviducal pores in front of and ventrad of inner setae. Genital papillae elliptical or dumb-bell-shaped elevations between segments (some or all) XVI/XXIII. Dorsal pores commence XI/XII. Gizzard in V; calciferous glands in X–XIII; intestine begins in XVI. Last hearts in XIII. Sperm-sac in XI, XII. Spermathecae in VIII, IX, with short diverticulum, opening opposite setae. Hab.—Cuullenbonc, near Mudgee, N. S. W.*

(15) Cryptodrilus dubius (BEDDARD).

C. Illawarrae, FLETCHER, loc. cit., p. 1546.

Definition. *Length,* 100 *mm.; breadth,* 3 *mm.; number of segments,* 270. *Prostomium incomplete. Clitellum, XIV–XVII, complete. Setae of outer couples twice as far apart as those of inner. Male pores in line with interval between setae* 1 *and* 2. *Oviducal pores to inside of and in front of inner setae. Genital papillae a ridge connecting male pores. Dorsal pores commence X/XI. Gizzard in V; no distinct calciferous glands; intestine begins in XVI. Last hearts in XII. Sperm-sacs in IX, XII. Spermathecae in VIII, IX, each with two short diverticula, opening just dorsad of inner seta. Hab.—Illawarra, N. S. W.*

I have been compelled to change the name of this species as there is another, *C. illawarrae;* the two species were, of course, assigned by FLETCHER to different genera. There seem to be possibly salivary glands of nephridial nature in segments v–vii. FLETCHER describes a variety with an additional pair of papillae between xvi/xvii from Blue Mountains.

(16) Cryptodrilus illawarrae (FLETCHER).

Megascolides (Notoscolex) Illawarrae, FLETCHER, loc. cit., p. 1523.

Definition. *Length,* 200 *mm.; breadth,* 7 *mm.; number of segments,* 395. *Prostomium incomplete. Clitellum, XIII–XXII, complete. Setae of outer row sinuous after segment*

XV, inner couple wanting on XVIII. Male pores on level with interval between inner setae. Dorsal pores commence XI/XII. No distinct calciferous pouches. Last pair of hearts in XII. Testes and funnels in XI; sperm-sacs in XII. Spermathecae in VIII, IX, with a single rosette-like diverticulum, opening in line with a little ventrad of first seta. Penial setae present. Hab.—Mount Kembla, Illawarra, N. S. W.

In the points not mentioned in the above, the species is stated by FLETCHER to agree with *C. camdenensis.*

(17) Cryptodrilus pygmaeus (FLETCHER).

Megascolides (?) (Notoscolex) pygmaeus, FLETCHER, loc. cit., p. 1525.

Definition. *Length,* 85 *mm.; breadth,* 4 *mm.; number of segments,* 200. *Prostomium incomplete. Clitellum, XIV–XIX. Setae of outer couples further apart than of inner. Male pores in line with interval between ventral setae, behind each a pore. Genital papillae a median ridge between XIX/XX, and XX/XXI. Dorsal pores commence XI/XII. Calciferous glands one pair in XII, XIII; salivary glands (nephridial) in V, VI; intestine begins in XV. Last pair of hearts in XII. Sperm-sacs in XI, XII. Spermathecae in VIII, IX, with a small diverticulum. Hab.—Illawarra.*

(18) Cryptodrilus rusticus, FLETCHER.

C. rusticus, FLETCHER, loc. cit., i (2), 1887, p. 570.

Definition. *Length,* 190 *mm.; diameter,* 7 *mm.; number of segmeuts,* 250. *Prostomium incomplete. Clitellum, XIII–XVII, complete. Male pores at the extremity of a dumb-bell-shaped papilla of which there are others on XVI/XVII, and XIX/XX, XX/XXI. Setae of dorsal pairs further apart than of ventral. Dorsal pores commence XIII/XIV. Gizzard in V; intestine begins on XVIII. Last hearts in XII. Septa VII/XIII thickened. Sperm-sacs in IX, XII; spermathecae in VIII, IX, two or three rudimentary caeca. Hab.—Burrawang, N. S. W.*

(19) Cryptodrilus camdenensis (FLETCHER).

Notoscolex Camdenensis, FLETCHER, loc. cit., p. 546.

Definition. *Length,* 148 *mm.; diameter,* 9 *mm.; number of segments,* 220. *Prostomium incomplete. Clitellum, XIV–XXIII, incomplete ventrally. Setae of outer rows further apart than of inner. Male pores on line with interval between seta* 1 *and* 2 *(the setae wanting). Oviducal pores ventrad of inner setae. Dorsal pores commence VIII/IX.*

Gizzard in VI; calciferous glands in XIV–XVI; intestine begins in XVIII. Septa VI/XIV thickened. Last hearts in XIII. Sperm-sacs in XI, XII; spermathecae in VIII, IX, with small lobulate caecum. Hab.—Burrawang, N. S. W.

It is mentioned that the intestine is coiled in a corkscrew fashion, when the worm is contracted.

(20) Cryptodrilus grandis (Fletcher).

Notoscolex grandis, Fletcher, loc. cit., p. 551.

Definition. *Length,* 760 *mm.; diameter,* 11 *mm.; number of segments* (?). *Prostomium incomplete. Clitellum,* $\overline{\text{XIII}}$*–XIX, complete. Setae in eight rows as in preceding species. Male pores on two papillae which dovetail in between the ends of two papillae formed by narrow transverse ridges on XVIII and XIX. Dorsal pores commence VIII/IX. Gizzard in VI; no calciferous glands; intestine begins in XVII. Septa VI/XIII are thickened. Sperm-sacs in IX, XII; spermathecae in VIII, IX, with small diverticulum. Hab.—Burrawang, N. S. W.*

(21) Cryptodrilus simulans, Fletcher.

C. simulans, Fletcher, loc. cit., iv (2), 1890, p. 998.

Definition. *Length,* 108 *mm.; diameter,* 5 *mm.; number of segments,* 220. *Prostomium incomplete. Setae of outer couples further apart than of inner. Male pores corresponding interval between setae* 1 *and* 2*; on a ridge-like swelling which is repeated on VII and XIX. Dorsal pores commence X/XI. Gizzard in V; calciferous glands in XIV, XV; intestine begins in XVII. Last hearts in XII. Sperm-sacs in XI, XII; spermathecae in VIII, IX, with rosette-like caecum. Penial setae present, not ornamented. Hab.—Bulli, Illawarra, N. S. W.*

Genus Microdrilus, Beddard.

Definition. Male pores on XVII. Spermiducal glands tubular with penial setae. Nephridia diffuse. Gizzards, two.

This genus is very near to *Digaster*. The principal reason which leads me to separate the two is the fact that the male pores of the present genus open on to segment xvii instead of xviii. Another feature which may perhaps be of generic value is the fact that only one of the three pairs of calciferous glands opens into the oesophagus; the other two open into it. This peculiarity of the calciferous gland has been hitherto

only found in the genera *Allolobophora* and *Lumbricus*. I have commented elsewhere on the curious points of similarity between this genus and *Benhamia*.

Microdrilus saliens, BEDDARD.

M. saliens, BEDDARD, P. Z. S., 1892, p. 683.

Definition. *Length, about 25 mm. Clitellum, XIII–XIX, complete except on XIX. Calciferous gland on XV, XVI, XVII, the anterior pair only open into gut. Setae paired. Dorsal pores commence IV/V. Oviducal pores to inside of ventral setae. Spermathecae two pairs with a single caecum. Penial setae undulated at extremity with fine notches at each bend. Hab.—Java, Penang.*

This species when alive showed the extreme agility of movement so characteristic of the genus *Perichaeta*. The spermiducal glands open independently of the sperm-ducts on to a semicircular elevation with a pore at each end; these large papillae are very conspicuous, and are so arranged that the straight side of each is opposed to that of the other. The sperm-duct is invested for the last two segments of its course by a thick muscular coat as in *Benhamia crassa*. The intestine begins in segment xviii.

Genus GORDIODRILUS, BEDDARD.

DEFINITION. **Small slender Oligochaeta with paired setae. Nephridia paired. Gizzard generally absent; a single median (rarely paired) calciferous gland in IX of peculiar structure. Hearts in X, XI. Spermiducal glands, two pairs (rarely one pair) with epithelial lining only one cell thick, opening in consecutive segments. Sperm-duct pore on XVIII (or XX) independent of spermiducal glands. Spermathecae two pairs (rarely one or absent) in VIII, IX, with at most rudimentary diverticula. Septal glands present in V–VII or VIII.**

This genus is, with the exception of *Gordiodrilus dominicensis*, confined to tropical Africa, preponderating greatly on the west side of the continent. Though apparently closely related to *Ocnerodrilus* and *Pygmaeodrilus*, it is to be distinguished from both by the peculiar structure of the calciferous gland, which is moreover, excepting in *G. robustus*, unpaired. The separate aperture of the sperm-duct is another point which separates this genus from the other two, as is also its position (on the eighteenth instead of the seventeenth segment).

There is a greater range of variation among the species of this genus than is the case with the related *Ocnerodrilus*.

The four species, *G. elegans*, *G. ditheca*, *G. dominicensis*, and *G. zanzibaricus*, form a distinct group, characterized by their small size, by the absence of a gizzard, and by the fact that the spermathecae do not communicate with the exterior by a long duct.

G. robustus is a stouter species, though small, with paired calciferous glands, with a well-developed gizzard, and with spermathecae with a long duct. The most abnormal species is, however, *G. tenuis*, which has some claims to be placed apart in a separate genus. It is extraordinarily long, and the ventral setae, like those of *Megachaeta*, are very much larger than the dorsal; the pores of the spermiducal glands are much further back than in the other species, and there is but a single pair of testes.

G. robustus serves to connect the genus *Gordiodrilus* with the nearly-related *Ocnerodrilus*.

As in *Ocnerodrilus* the ventral setae, near to which the spermiducal glands open, are present or absent. In *G. tenuis* these setae are present and unaltered; in *G. elegans* they seem to be completely absent; in *G. zanzibaricus* one of the two setae of the ventral pair only is absent, the others being present and unaltered. The amount of variation in the position of the male pores is unusual. In *G. robustus* and *G. zanzibaricus* the pores of the spermiducal glands are upon segments xvii, xviii; in *G. elegans* they have moved a segment further back and are upon xviii, xix[1]. *G. tenuis* is in this, as in other respects, most abnormal; the pores in question are in that species upon segments xx and xxi. The various pores connected with the male efferent apparatus open on to a pronounced ridge, one on either side, with an undulating outline, being deeper at the two ends than in the middle. The two ridges seem to join in front and behind, forming thus a sucker-like structure.

(1) **Gordiodrilus tenuis**, Beddard.

G. tenuis, Beddard, Ann. and Mag. Nat. Hist., July, 1892, p. 75.

Definition. *Length*, 90 *mm.; diameter*, 1 *mm. Ventral setae, present on genital segments, four times the size of lateral setae. Clitellum, XIV–XXVII, saddle-shaped. Spermiducal gland pores on XX, XXI, behind setae; male pore on XXI, in front of setae. Septa, V/XII, thickened. Testes, one pair in XI; sperm-sacs in X–XIII. Spermathecae, two pairs, with long duct. Hab.—Assaba, W. Africa.*

[1] In my paper upon this genus there is unfortunately some little confusion as to this matter; the segments are rightly stated on one page, and misstated on another.

The appearance of this worm during life was something like that of a Lumbriculid; it was extraordinarily long and thin, and fairly active in its movements. The large ventral setae can be easily felt when the worm is handled; under those circumstances it adheres to the finger by the setae. Its superficial resemblances to *Megachaeta* appear, from MICHAELSEN'S description of the latter, to be not inconsiderable. Judged by external characters it would be very probably referred to that genus.

It has a milky-white appearance owing to the presence of a great quantity of coelomic corpuscles.

The ventral setae, though so much larger than the lateral, are not themselves equisized; the innermost of the two is distinctly larger than the outermost setae of the pair. The nephridia, which seem to commence in the sixth segment and open in front of the lateral setae, are covered with an abundant coating of peritoneal cells. The intersegmental septa are very much more extensive than is the diameter of the body; hence it results that they are placed within each other like a series of very deep cups, a common arrangement among worms but rather exaggerated here.

(2) Gordiodrilus robustus, BEDDARD.

G. robustus, BEDDARD, loc. cit., p. 82.

Definition. *Length, about* 32 *mm.; number of segments,* 90. *Setae of segments V–VII larger; ventral setae of segments XII and XIII very large, present on genital segments. Clitellum, XIII–XVII, saddle-shaped. Spermiducal gland pores upon XVII, XVIII; male pores upon XVIII. Gizzard in segment VIII; calciferous glands paired. Septa separating segments V/VIII, much thickened, those between VIII/XII slightly thickened. Spermathecae in VII, VIII; duct long and slender. Hab.—Lagos.*

This species is furthermore marked by an oval median papillae upon segment xix. The spermathecae have thin walls and were found to be much crumpled in sections.

(3) Gordiodrilus elegans, BEDDARD.

G. elegans, BEDDARD, loc. cit., p. 84.

Definition. *Length, about* 40 *mm. Setae of ventral pairs absent on segments XVIII, XIX. Clitellum, XIII–XVIII, saddle-shaped. Spermiducal pores on XVIII, XIX; male pores exactly between them. Septa, V/X, thickened. Sperm-sacs in IX–XII. Spermathecae in VIII and IX, each with two rudimentary diverticula; the duct is short. Hab.—Lagos.*

The septal glands occupy segments v–vii.

The nephridia of this species commence in the fourth segment; after the first few

pairs (beginning in the thirteenth segment in one specimen, in the nineteenth segment in another) they are coated with a thick layer of peritoneal cells.

The spermathecae open between vii/viii and viii/ix; in one individual they both lay in the eighth segment. The duct is quite short, and ensheathed in a thick muscular layer.

(4) Gordiodrilus ditheca, Beddard.

G. ditheca, Beddard, loc. cit., p. 90.

Definition. *Length, about* 40 *mm. Clitellum, XIII–XVII. Spermiducal pores on XVIII. Spermathecae in VII, without diverticula Hab.—Lagos.*

This species only differs from the last in the single pair of spermiducal glands and spermathecae.

(5) Gordiodrilus dominicensis, Beddard.

G. dominicensis, Beddard, loc. cit., p. 91.

Definition. *Length,* 26 *mm.; diameter,* 11 *mm.; number of segments,* 60. *Setae of ventral pairs absent upon eighteenth and nineteenth segments. Spermiducal pores on XVIII, XIX. Septa VI/IX specially thickened; those between V/VI and IX/X tolerably strong. Spermatheca absent. Hab.—Dominica, W. Indies.*

The principal distinguishing mark of this species is, of course, the absence of the spermathecae. It is, however, just possible that the spermathecae were not yet developed, as the worm had no clitellum. The septal glands extend back as far as the eighth segment. The nephridia commence in the fifth segment; from the tenth segment onwards the nephridia are invested with a mass of clear peritoneal cells.

(6) Gordiodrilus zanzibaricus, Beddard.

G. zanzibaricus, Beddard, Q. J. M. S., xxxvi, 1894, p. 252.

Definition. *Length,* 25 *mm. Clitellum, XIII–XIX. Ventral setae of segments XVII, XVIII, represented by one seta only. Spermiducal pores upon XVII, XVIII. Septa between segments V/XI thickened, particularly those between VI/IX. Sperm-sacs in XII; sperm-masses in X, XI. Spermathecae in VIII, IX, with short muscular duct. Hab.—Zanzibar.*

The septal glands of this species are well developed, and extend as far back as the seventh segment, there being traces of a pair of these glands in the eighth.

The nephridia commence in the fifth segment; in and after the tenth they are invested by a layer of clear peritoneal cells.

The ventral surface of the eighth segment, and the anterior half of the ninth, are modified, the cells of the epidermis being tall and glandular; this layer of cells is not interrupted in the middle ventral line.

Genus OCNERODRILUS, EISEN.

Syn. **Pygmaeodrilus**, MICHAELSEN.

DEFINITION. **Small, often aquatic, worms. Setae paired, sometimes absent upon segment XVII, upon which sperm-ducts open. Spermiducal glands lined with a single layer of cells. Gizzard absent; calciferous glands paired in IX. Nephridia paired. Sperm-ducts open in common with spermiducal glands.**

For a long time this genus was only known by a single species, *Ocnerodrilus occidentalis*, described some years ago by EISEN (**9**); in 1891 I described a second species, *O. eiseni* (**20**); more recently still (**1**), EISEN has published a paper containing an account of eight new forms, while MICHAELSEN and I have described several African species, formerly relegated to the genus *Pygmaeodrilus*. We are, therefore, in possession of a considerable amount of information about this genus. The species of the genus are all of small size; they are partly aquatic, but usually terrestrial in habit. The genus is easily separable from *Gordiodrilus*, on account of the paired diverticula which have a different structure from those of the latter; another important difference is in the fact that the sperm-duct pores are always on the seventeenth segment in the present genus, and usually on the eighteenth segment in the genus *Gordiodrilus*, and that the sperm-ducts open by the same pore as the spermiducal glands; the calciferous glands are, however, paired in *G. robustus;* another intermediate form is *O. limicola*, where there are also two pairs of spermiducal glands on exactly the same segments as those on which they occur in *G. robustus;* but in *O. limicola* the sperm-ducts open into the first pair of these glands, and the similarity to *Gordiodrilus* is thus reduced to the mere doubling of the spermiducal glands, which is of no more importance than the fact of the reduction of the spermiducal glands to a single pair in *G. ditheca*.

The ten species of *Ocnerodrilus* differ in four principal characters, besides others of less importance.

There are considerable variations in the condition of the ventral pairs of setae in

the seventeenth segment; indeed, every possible variation occurs. This segment is the one which bears the male pores. In the type-species of the genus, *O. occidentalis*, and in one other, *O. limicola*, both setae of the pair are present and unchanged; this may be fairly regarded as the primitive condition. The next stage is shown in those species in which one or other of the two setae have disappeared. Finally, the majority of the species (five) are entirely without the ventral pairs of setae.

Eisen considers that the genus is naturally divisible into two groups; in one of these the lower end of the sperm-duct is enveloped by a thickish muscular sheath; in the other there is no such sheath. The former state of affairs characterizes these species; the character is a peculiar one, and is met with in other worms belonging to different families; it may be noted that all the species, viz. *O. agricola*, *O. rosae*, and *O. contractus*, which present this structural peculiarity, have no ventral setae upon the seventeenth segment.

O. limicola is alone in possessing two pairs of spermiducal glands. Though in this character the species in question agrees with the nearly related genus *Gordiodrilus*, it must not be forgotten that an important difference between the two is the fact that in *Ocnerodrilus* the sperm-ducts open in common with the spermiducal gland and on to the seventeenth segment.

The spermathecae (of which there is never more than one pair) are nearly always in the ninth segment; in *O. eiseni*, however, they are in the eighth segment, and *O. occidentalis* is entirely without these organs.

A fifth point in which the species vary is in the number of the hearts; in the great majority there are only two pairs of these; but *O. limicola* and *O. hendrici* have an additional pair in the ninth segment, which, in the latter species at any rate, is a pulsating vessel like the two which follow.

Of minor importance, as it appears to me, are the relative size and the lobation of the septal glands, upon which Eisen is inclined to lay considerable stress; of less importance still, perhaps, are the relative size and form of the sperm-sacs, where these are—and this applies to the majority—four pairs in segments ix–xii. The degree of sexual maturity would surely be an important factor in causing differences of this kind. The clitellum too shows differences in extent.

One species, *O. lacuum*, differs from the rest in having dorsal pores (at least Michaelsen has not mentioned them in any species): in the single pair of testes: in the absence of diverticula to the spermathecae: in the presence of gizzards, and in the saddle-shaped clitellum. On the other hand, it presents the following characteristic features of the genus; in the male pores being on the seventeenth segment: in the fact that the sperm-duct is enveloped in a muscular sheath: in

the existence of a single pair of spermathecae in the ninth segment, and in the single pair of calciferous glands in the same segment. Pending further information about the lower Cryptodrilids of Africa, I retain it in the same genus as the species described by MICHAELSEN.

(1) Ocnerodrilus occidentalis, EISEN.

O. occidentalis, EISEN, Nova Acta Reg. Soc., Upsala, x (3), 1879, p. 1.

Definition, *Length,* 15 *mm. Clitellum, XIII–XX. Setae not absent from segment XVII. Testes only one pair (in X); sperm-sacs only one pair (in XI). Spermiducal glands very long reaching to XXVI. Spermathecae absent. Hab.—Fresno, California.*

(2) Ocnerodrilus eiseni, BEDDARD.

O. Eiseni, BEDDARD, Trans. Roy. Soc., Edinb., 1890, p. 563.

Definition. *Length,* 25 *mm. Clitellum, XIII–XVIII. Ventral setae of segment XVII wanting. Spermiducal glands slightly coiled extending through three segments. Spermathecae in VIII. Hab.—British Guiana.*

(3) Ocnerodrilus beddardi, EISEN.

O. Beddardi, EISEN, Proc. Cal. Ac. Sci., 1892, p. 230.

Definition. *Length,* 40 *mm. Clitellum, XIII–XIX. Inner setae of ventral pair of segment XVII wanting. Septa begin IV/V; septa separating V/IX, much thickened. Septal glands in V–VIII, last pair small, the largest in V. Hearts in X, XI, arising from supraintestinal vessel. Nephridia commence in IV, the four anterior being small and comparatively rudimentary. Spermiducal glands small only extending through two or three segments. Spermathecae in IX with numerous rudimentary diverticula at free end. Hab.—Baja California, near San José del Cabo.*

(4) Ocnerodrilus guatemalae, EISEN.

O. guatemalae, EISEN, loc. cit., p. 249.

Definition. *Length,* 40 *mm. Clitellum, XIV–XVIII. Outer setae of ventral pair of segment XVII wanting. Septal glands of V largest, those of VII and VIII small and nearly equisized. Spermiducal gland confined to a single segment. Spermathecae very small. Hab.—Guatemala, in soil.*

In the characters not mentioned above the present species agrees with *O. beddardi.*

(5) Ocnerodrilus sonorae, Eisen.

O. sonorae, Eisen, loc. cit., p. 251.

Definition. *Clitellum, XIV–XVII. Outer setae of ventral pair of segment XVII wanting. Septal glands in V–VIII, nearly equal in size, slightly diminishing from before backwards. Spermiducal gland confined to two segments, the muscular part not narrower than the glandular. Spermathecae without differentiated muscular duct. Hab.—Sonora, Mexico; in moist soil near irrigation canals.*

(6) Ocnerodrilus hendriei, Eisen.

O. Hendriei, Eisen, loc. cit., p. 252.

Definition. *Length,* $1\frac{1}{2}$ *inch by* $\frac{3}{4}$ *line. Clitellum, XIII–XVIII. Ventral pair of setae on XVII wanting. Septal glands of V larger than VI; those of VII and VIII very small and equisized. Spermiducal glands occupy about two segments. Spermathecae in IX very small. Hab.—Saint Tomas, Guatemala; on the road after rain.*

(7) Ocnerodrilus limicola, Eisen.

O. limicola, Eisen, loc. cit., p. 254.

Definition. *Clitellum, XIII–XIX. Ventral setae of segment XVII present. Septal glands of V slightly larger than the following pairs; those of VIII the smallest. Two pairs of spermiducal glands in XVII, XVIII, the former, as usual, connected with sperm-duct. Spermathecae in IX very small. Hab.—Guatemala; in mill pond.*

It is not quite certain from Eisen's description whether the ventral setae of xvii are or are not missing; in the description of the species they are said to be wanting once (p. 255), and on the next page to be generally present; on p. 275 they are again said to be wanting, and on the 'Table of Species' (facing p. 282) to be present.

(8) Ocnerodrilus rosae, Eisen.

O. Rosae, Eisen, loc. cit., p. 258.

Definition. *Length,* 1 *inch by* $\frac{3}{4}$ *line. Clitellum, XIII–XVIII. Ventral setae of XVII wanting. Septal glands of V hardly larger than of VI. Intestine begins in XIII. Spermiducal glands slender and long, the muscular part nearly half as long as glandular. The sperm-ducts are ensheathed near to their opening with muscular fibres. The*

spermathecae are long and cylindrical in IX. Hab.—San Antonio, Guatemala; under damp moss at springs.

(9) Ocnerodrilus contractus, Eisen.

O. contractus, Eisen, loc. cit., p. 262.

Definition. *Clitellum, XIII–XVIII. Ventral setae of segment XVII wanting. Septal glands of V equal in size to those of VI, which is largest of four; that of VIII very small. Spermiducal gland long; glandular part* $1\frac{1}{2}$ *times as long as muscular part. The sperm-ducts are ensheathed near to opening with muscular fibres. Spermathecae not so large as that of* O. rosae, *but larger than in* O. hendriei *in IX. Hab.—Guatemala; in pools.*

(10) Ocnerodrilus agricola, Eisen.

O. agricola, Eisen, loc. cit., p. 265.

Definition. *Clitellum, XIII–XVIII. Septal gland of V larger than that of VI; gland of VIII smallest. Ventral pair of setae in segment XVII wanting. Spermiducal glands extending as far back as segment XXVIII; glandular part four times and more the length of muscular part. Sperm-duct enveloped terminally by muscular fibres. Spermathecae globular with muscular duct in IX. Hab.—Guatemala; in moderately dry soil.*

(11) Ocnerodrilus quilimanensis (Michaelsen).

Pygmaeodrilus quilimanensis, Michaelsen, JB. Hamb. wiss. Anst., vii, 1890, p. 12.

Definition. *Length,* 38 *mm.; diameter,* 1·5 *mm.; number of segments,* 110. *Clitellum, XIV–XVI, complete. Gizzard absent (?); intestine begins gradually in segment XII. Testes, two pairs; sperm-sacs in IX, XII. Spermiducal glands open into a terminal muscular sac, into which the sperm-duct appear to open. Spermathecae with a circle of minute diverticula. Hab.—Quilimane, East Africa.*

(12) Ocnerodrilus bukobensis (Michaelsen).

Pygmaeodrilus bukobensis, Michaelsen, loc. cit., 1892, ix, 2, p. 4.

Definition. *Length,* 120 *mm.; diameter,* 2 *mm.; number of segments,* 120. *Clitellum, XIII–XVIII, complete. Gizzard absent. Testes, two pairs; sperm-sacs in IX, XII. Spermathecae with two or four large diverticula. Hab.—Victoria Nyanza, near Bukoba.*

This species is also to be distinguished from the last by the near approximation

of the spermiducal gland pores; there seems to be no muscular sac into which these open. There are papillae, one pair in front of and to the outside of the male pores, the second pair in a corresponding position behind the male pores. The sperm-ducts open independently of the spermiducal glands a little to the outside of them.

(13) Ocnerodrilus affinis (MICHAELSEN).

Pygmaeodrilus affinis, MICHAELSEN, loc. cit., p. 6.

Definition. *Length,* 60 *mm.; diameter,* 1·5 *mm.; number of segments,* 106. *Clitellum, XIII–XVIII, complete. No gizzard. Spermathecae single and median, with four diverticula. Hab.—Victoria Nyanza, near Bukoba.*

The genitalia of this species appear to be like the last with the exception of the points mentioned in the above diagnosis, but they were not in a good state of preservation. The thick muscular duct of the spermathecae shows signs of a division into parts. There are four papillae, one pair in front and one behind male pore, on level with ventral setae.

(14) Ocnerodrilus lacuum (BEDDARD).

Pygmaeodrilus lacuum, BEDDARD, Q. J. M. S., xxxiv, 1893, p. 259.

Definition. *Length, about* 25 *mm.; number of segments, about* 120. *Dorsal pores present. Clitellum, XIII–XXVI, saddle-shaped. Ventral setae of segment XVII absent. Septa, V/X, thickened; septal glands well developed. Gizzards, two in VI, VII; intestine begins in XII. Nephridia commence in segment VI. Testes, one pair in XI; sperm-sacs in XII. Sperm-ducts open in common with spermiducal gland, uniting just at pores. Spermathecae in IX, without diverticula. Hab.—Lagos, West Africa.*

This species appears to possess no papillae. The above description will show that there is no danger of confusing this species with the others. The living worm was very slender and largely of a chalky-white colour, caused by numerous coelomic corpuscles. The spermiducal glands (at any rate of one example) were very long, and folded extending through six or seven segments. The ventral setae of segment xviii are absent.

Genus NANNODRILUS, BEDDARD.

DEFINITION. Small worms with paired setae. Nephridia paired. Gizzard rudimentary. Calciferous gland in IX. Spermiducal glands lined by a single layer of cells; posterior of two pairs open on each side into a bursa copulatrix, which

opens on to a penis, and which also receives sperm-ducts. On segment in front (XVII) open anterior pair of spermiducal glands.

Nannodrilus africanus, Beddard.

N. africanus, Beddard, P. Z. S., 1894, p. 388.

Definition. *Length, about 2 in. Clitellum, XIII–XVII. Septa, V/IX, thickened. Rudimentary gizzards in VII, VIII. Nephridia commence in V, without end sac. Last heart in XI. Spermathecae, one pair in VII, without diverticulum. Hab.—West Africa; aquatic.*

Family ACANTHODRILIDAE

Definition. **Large or small Oligochaeta, usually terrestrial, occasionally aquatic, in habit. Setae, 8, 12, or numerous upon each segment of the body. Male pore upon segment XVIII; pores of spermiducal glands upon segments XVII and XIX[1]. The latter are tubular structures, generally accompanied by penial setae. Spermathecae, nearly always two pairs in segments VIII and IX with diverticulum or diverticula.**

Anatomical characters.

The Acanthodrilidae are of various sizes; they range from 29 mm. to several feet in length. They have all of them a *prostomium*, which may be either simply a prolongation of the buccal segment, or may be received into an excavation of the anterior margin, or may be, in addition, continued on to the buccal segment by grooves which are in many cases (e.g. *Acanthodrilus novae-zelandiae*) prolonged as far as the posterior limits of that segment.

The *setae* are never ornamented at the extremity[2], as in the Geoscolicidae; they are usually eight in each segment; but in *Deinodrilus* there are twelve to each segment, and in the genus *Plagiochaeta* 25–27 couples of setae. When the number of setae is restricted to eight, these may be arranged in closely approximated couples (e.g. *A. ungulatus*), or may be somewhat separated from each other, as in *Octochaetus*

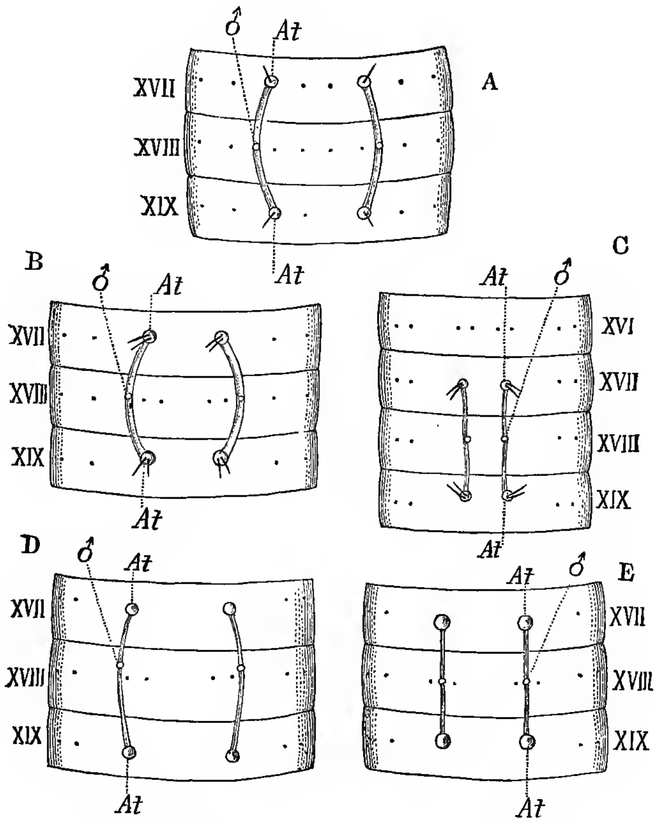
[1] *Diplocardia* is the only certain exception to this statement.

[2] Except in the case of *Benhamia togoensis*.

multiporus. Finally, we have in *A. capensis* an intermediate condition: the setae are closely approximated in the front region of the body and more separated behind.

In the genus *Octochaetus*, as in *Acanthodrilus*, the ventral setae of the eighteenth segment are present; the ventral setae of the seventeenth and nineteenth segments are wanting, being replaced by the penial setae. *O. antarcticus* and *O. multiporus*[1] show an interesting intermediate condition; the setae of the eighteenth segment are present, the male pore lying just dorsad of the outermost of the two. On the seventeenth and nineteenth segments the penial setae occupy the place of the outer of the two setae of each ventral pair, but the inner setae of the ventral pair are present and apparently unmodified. The penial setae are rather short and often, at any rate, less curved than is usually the case with these setae. The setae of these genital segments are in a simple condition which nearly reproduces the state of affairs in such a form as *Gordiodrilus*. The genus *Kerria*, which is in some respects the simplest Acanthodrilid, has no penial setae but only the ordinary and unmodified setae of those segments. *O. antarcticus* is only just removed from that simple condition, which is possibly characteristic of Rosa's *A. spegazzinii*, and is a reason for placing that species in my genus *Kerria*.

Fig. 45.



GENITAL SEGMENTS OF A NUMBER OF ACANTHODRILIDS.

A. *Octochaetus antarcticus.* B. *Acanthodrilus capensis.* C. *Benhamia.* D. *Acanthodrilus smithii.* E. *Acanthodrilus novae-zelandiae.* ♂ Male pore. *At.* Spermiducal gland pores connected by a groove. Penial setae omitted in D and E.

[1] I erroneously stated in my original description of this worm (8) that penial setae were absent.

In the genus *Octochaetus* the male pores are always outside of the ventral setae; this is not always the case with *Acanthodrilus; A. falclandicus* is like *Octochaetus* in this respect, but *A. novae-zelandiae* has the male pores between the two setae of the ventral pair; the conspicuous groove which in this and in other species connects the two atrial pores of each side of the body, and bears the sperm-duct-pore in its course, passes exactly half way between the closely approximated setae of the ventral pair (see woodcut, fig. 45).

The *clitellum* is frequently saddle-shaped, that is, the thickened epidermis is confined to the back and sides of the segments upon which the clitellum is developed, and does not extend on to a ventral area bounded by the ventralmost setae of each side: this state of affairs is, however, not always found upon the first few segments of the clitellum; it commonly commences with the segment just in front of that bearing the reproductive pores. The clitellum is very variable in extent; in *Deinodrilus benhami* it is limited to three segments (xiv–xvi); in *Trigaster lankesteri* segments xiii–xl constitute the clitellum; the most usual segments upon which it is developed are xiii–xvii.

Dorsal pores are usually present; but in a few species (e.g. *A. georgianus*) they are entirely absent. The position of the first pore is naturally variable.

In mature, and generally also in immature, Acanthodrilidae, the *male genital pores* are extremely conspicuous; these pores are nearly invariably—most exceptions that have been described will probably prove in the long run not to be exceptions—upon the seventeenth and nineteenth segments; these apertures are those of the spermiducal glands, and they are generally situated upon prominent papillae, corresponding in position to the ventral setae; on the eighteenth segment are the minute pores of the sperm-ducts. Through the spermiducal gland-pores protrude the penial setae, when these are present. A groove always connects the two pores of each side of the body. Quite exceptionally, *Neodrilus monocystis* has only a single pair of spermiducal gland-pores; these are on the seventeenth segment; a groove connects the pore of each side with the sperm-duct pore on the eighteenth segment.

The *spermathecal pores* in almost every species lie upon the boundary-line between segments vii/viii, viii/ix, and correspond in position to the pores on xvii, xix; in their neighbourhood there are occasionally *papillae*, but the presence of such papillae is not at all characteristic of the family, as it is of the family Perichaetidae.

The *oviducal pores* lie upon the fourteenth segment; there are only one or two species (e.g. *Benhamia bolavi*) in which the female pore is single and median as it is in the genus *Perichaeta* (s.s.).

The *alimentary canal* presents the same subdivisions as in other earthworms.

The buccal cavity is followed by an oesophagus which passes into the intestine at about the eighteenth segment, but the exact position varies.

The oesophagus is differentiated into a gizzard in most Acanthodrilidae; in all the members of the genus *Benhamia* and in *Diplocardia* there are, indeed, two separate gizzards; and in *Trigaster* there are no less than three of these organs. In a few species, particularly those which are aquatic in habit, the gizzard is absent; in some of these species, however, the gizzard, although it appears on a superficial inspection to be completely unrepresented, can be recognized in longitudinal sections; it is so, for instance, with *A. falclandicus* (described by myself as *A. georgianus*). The gizzard in all the Acanthodrilidae lies well forward, even so anteriorly as the fifth segment (e.g. *Octochaetus huttoni*); it may or may not be confined to a single segment.

Calciferous glands are very common, but not universal, in the family. They are particularly prone to be absent in the genus *Acanthodrilus* itself; thus they are said to be absent in *A. pictus;* in the genus *Benhamia,* on the other hand, they appear to be invariably present, and to the number of three pairs; in *Benhamia,* moreover, the calciferous glands seem to be more independent of the oesophagus than is the case with other Acanthodrilids; this, however, is not much more than an appearance; for in *A. dissimilis,* for example, transverse sections show that the calciferous glands are really quite distinct from the oesophagus, but, on account of their large size, they completely encircle the gut, and, on dissection, seem to be merely local thickenings of the oesophagus. The calciferous glands lie rather far back as compared with many other earthworms, such as *Pontoscolex;* in *Benhamia* they occupy segments xiv, xv, xvi, very often, if not always; in *O. multiporus* the last pair is even in segment xvii or xviii. For the details of the numbers of pairs, and their position, in the different species, reference must be made to the descriptions of the species. There is nothing characteristic about the structure of these organs in the present family.

The *intestine* begins as early as the sixteenth segment in *Plagiochaeta,* but usually it does not commence before the eighteenth segment. In *Plagiochaeta* there is, according to BENHAM, no typhlosole; in other species the typhlosole is variable in its development; in *O. multiporus* the typhlosole is large and trifid in transverse section; in *A. novaezelandiae* the typhlosole is inconspicuous; in *Benhamia* there is a subsidiary typhlosole, one on either side of the main typhlosole. *Plagiochaeta* is almost unique among the Oligochaeta for the fact that the intestine is spirally twisted. The intestine is totally without caeca or glands of any description.

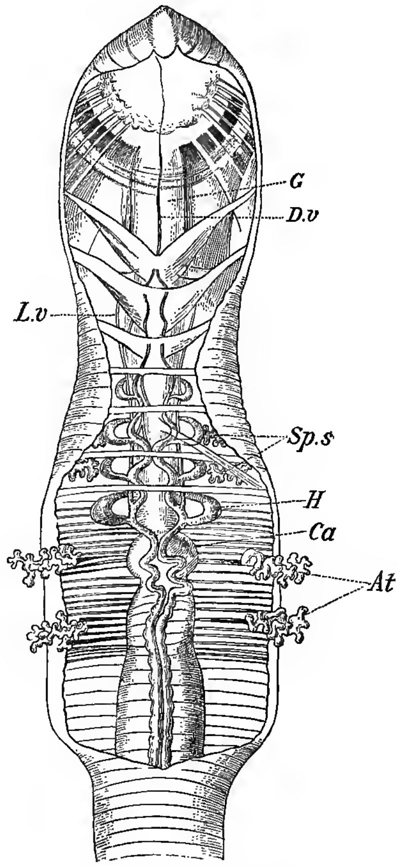
The *nephridia* in this family are sometimes paired and sometimes diffuse; in the restricted genus *Benhamia* they are always diffuse; so too in *Octochaetus;*

but in *Acanthodrilus* the nephridia are as invariably paired. It is, indeed, upon these characters that the genera of the Acanthodrilidae are distinguished. In the genus *Acanthodrilus* the paired nephridia in a few species (e.g. *A. novae-zelandiae* and *A. dissimilis*) alternate in position from segment to segment; this is also found in *Plagiochaeta;* the alternation of the nephridia is coupled with a difference in structure; I have, however, already gone into this matter at some length (p. 38), and need not, therefore, return to it again. It may, nevertheless, be pointed out that it is only among the New Zealand species that this peculiarity is met with. Where the nephridia are diffuse, the external apertures are, of course, not visible; they are too minute to be detected by the unarmed eye. There is generally an accumulation of nephridia in the anterior segments; in *Octochaetus*, and doubtless in other species, when they come to be better known, the same thing will be found; the anterior nephridia form a compact mass which opens by a duct into the buccal cavity. This state of affairs is not peculiar to this genus, but occurs in other Oligochaeta. *O. multiporus* shows one peculiarity, at present unique in the Oligochaeta; in a few of the posterior segments the nephridia are particularly abundant, and open, not only on to the exterior by numerous pores in each segment, but also into short diverticula of the hind gut. In this region of the body the nephridia are, exceptionally, provided with funnels.

The *vascular system* of the Acanthodrilidae is constructed upon the same plan as is that of most other terrestrial Oligochaeta; unfortunately there is no published account of the vascular system derived from a study of the living worm, such as we possess of *Megascolex* and *Pontoscolex;* the dorsal vessel is occasionally double, a condition which occurs in other Oligochaeta; the doubling of the dorsal vessel is chiefly met with in the New Zealand Acanthodrilidae, but not in all of them; it characterizes *O. multiporus*, *O. huttoni*, *O. thomasi*, and *O. antarcticus;* in these species the dorsal trunk is completely double from end to end of the body; in *A. novae-zelandiae* and in *A. rosae* the tube is double, except where it passes through the septa; at these points the two tubes become united. Above the oesophagus runs a supraintestinal trunk, which is connected with the posterior of the peri-oesophageal vessels; of these there are a number of pairs, and usually the last four of these are larger than the others, sometimes there are only three of these intestinal hearts; when there are four the last lies in the thirteenth segment; they are connected with the dorsal as well as with the supra-intestinal vessel; there is often, perhaps always, a pair of lateral vessels running along the body-wall in the anterior segments; according to Horst these vessels arise from the dorsal vessel, instead of arising as do their homologues in *Perichaeta* from the oesophageal plexus.

The *generative system* of the Acanthodrilidae is very characteristic: the testes and the ovaries occupy the usual segments; as a rule they are upon the front walls of their segments as is nearly universal; but in *A. annectens*, as was pointed out by myself some years ago, the gonads are affixed to the posterior wall of their segments in close connexion with the ducts of the generative products, actually in contact with the funnels; *Octochaetus* is peculiar in that the ovaries alone have this abnormal position, the other gonads being normal in situation. A few species have only one pair of testes; this is the case with *Kerria spegazzinii*, and with *A. pictus*. In *A. annectens*, *A. paludosus*, and *Diplocardia* the sperm-ducts run within the thickness of the body-wall; probably this is so with other species, though the above mentioned species are the only ones in which this very unusual course of the sperm-ducts has been described. The two sperm-ducts of each side of the body remain separate until their opening on to the exterior; it used to be thought that each of them opened in connexion with one of the spermiducal glands; but it is now certain that in many species, and it is probable that in all, the sperm-ducts open separately from those glands on to the eighteenth segment. The spermiducal glands are long tubes which are in communication with the orifices upon the seventeenth and nineteenth segments already referred to. They consist of a proximal glandular and a distal muscular portion; the glandular part of the tube has in all the genera of the Acanthodrilidae, except *Kerria*, a lining of two layers of epithelial cells; its structure in fact is like that of the clitellum; in *Kerria*, as in *Pygmaeodrilus*, *Ocnerodrilus*, and *Gordiodrilus*, the spermiducal gland is lined by only a single layer of cells; opening in common with the spermiducal glands is a sac of penial setae in very many—the majority—of Acanthodrilidae; in a few species there are two kinds of setae, plain and ornamental, in a single bundle; these are absent in the genus *Kerria*.

Fig. 46.



OCTOCHAETUS THOMASI.

G. Gizzard. *D.v.* Dorsal vessel *L.v.* Lateral vessel. *Sp.s.* Sperm-sacs. *H.* Hearts. *Ca.* Calciferous glands. *At.* Spermiducal glands.

The *spermathecae* of the Acanthodrilidae are nearly always two pairs only; in *)iplocardia communis*, however, there are, exceptionally, three pairs; in all the ıembers of the family, except *Kerria*, the spermathecae have a diverticulum or everal diverticula; it may happen that these appendices are so minute and so oncealed within the wall of the main pouch that they are invisible without ıicroscopical examination; but such examination shows them to be invariably resent; these organs are invariably placed in the eighth and ninth segments. In few species, e.g. *A. ungulatus* and *Benhamia beddardi*, there are sacs of modified etae, very similar to the penial setae, in the neighbourhood of the spermathecae; hey are often accompanied by glands.

Affinities of Acanthodrilidae.

This family of earthworms is not so easily separable from other families as it vas some years ago before the discovery of types like *Neodrilus* and '*Acanthodrilus*' *pegazzinii;* BENHAM'S new genus *Plagiochaeta*, to which BOURNE'S '*Perichaeta*' *tuarti* may, perhaps, be referable, indicates a closer approach to the family Perihaetidae even than *Deinodrilus;* with regard to this latter genus I pointed out its ntermediate characters between *Perichaeta* and *Acanthodrilus* in regard to the setae nd the clitellum; the setae are twelve in number to each segment, and the clitellum ccupies the three segments found in nearly all the members of the genus *Perichaeta* s.s.). In *Plagiochaeta* there is an agreement with the Acanthodrilidae in the xistence of four spermiducal glands each provided with its bundle of penial setae, n the presence of calciferous glands, and in the form of the spermathecae; but the etae are very numerous in each segment, being arranged in a series of about twentyive pairs; the paired condition of numerous setae is unlike the condition of the etae in the Perichaetidae, where a grouping into pairs is not known unless in *Megascolex sylvestris* of HUTTON, which may indeed be referable to the genus *Plagiochaeta*.

The disappearance, in *Neodrilus*, of the posterior pair of spermiducal glands night seem to indicate an approach to the family Cryptodrilidae; MICHAELSEN (**10**) ıas compiled a very instructive table of the characters of two species of the Cryptodrilid genus *Dichogaster* and *Benhamia rosea;* practically the only difference etween the Acanthodrilid and the Cryptodrilid is the presence in the latter of two airs of spermiducal glands; MICHAELSEN, however, has perhaps not sufficiently mphasized the fact that in the Acanthodrilidae the sperm-ducts never open on to he same segment as the glands; whereas in *Dichogaster* and in all Cryptodrilids

(except *Microscolex modestus*) they do; but it might be replied to this that in *Dichogaster damonis*, there are three pairs of tubular glands having the structure of the spermiducal glands of these and other earthworms.

Eliminate two of these three pairs and the condition found in the undoubtedly Acanthodrilid genus *Neodrilus* is arrived at. I think it must be admitted that the Acanthodrilidae have near relations to the Cryptodrilidae. At present, however, they differ by the situation of the spermiducal glands and the sperm-duct pores upon two or three consecutive segments.

The genus *Kerria* seems to tend in the direction of the small group Ocnerodrilidae[1]; it has, as has the genus *Ocnerodrilus* and its near ally *Gordiodrilus*, spermiducal glands composed of only a single layer of epithelium; the spermathecae have no appendices, and there is a single pair of calciferous glands in the ninth segment. If the description by PERRIER of the position of the spermiducal glands on consecutive segments in *A. obtusus* be confirmed, there is another point of similarity between *Acanthodrilus* and *Gordiodrilus*. But this has, in my opinion, yet to be put beyond legitimate doubt.

The genera of Acanthodrilidae.

The family Acanthodrilidae can be divided up into several genera; there can be no doubt of the distinctness of *Deinodrilus* and *Plagiochaeta*, the characters of which are given below. Whether the absence of the second pair of spermiducal glands and spermathecae is sufficient to distinguish my genus *Neodrilus* is not by any means so certain; the original description of this worm has been confirmed (and added to) by BENHAM; in *A. schmardae* one of the two pairs of glands, and similarly one of the two pairs of spermathecae, is decidedly smaller than the other; this leads, therefore, in the direction of *Neodrilus*; moreover, we have in the not far distant genus *Gordiodrilus* one species in which the spermiducal glands are reduced to a single pair; considering the close resemblance which *Neodrilus* bears in other characters to the genus *Acanthodrilus*, I am of opinion, that it should not be separated generically from such a form as *A. dissimilis*.

In a recent paper ROSA has described a remarkable species of '*Acanthodrilus*,' which he named '*Acanthodrilus spegazzinii*.' This Acanthodrilid has only one pair of testes, and the spermathecae have no diverticula. In a worm which I have more recently (**25**) described from the Pilcomayo river the same characters are found; in addition to this the spermiducal glands are lined by a single layer of cells only; it

[1] Including *Ocnerodrilus*, *Nannodrilus*, and *Gordiodrilus*.

is not stated by ROSA whether this is also the condition of the glands in '*Acanthodrilus spegazzinii*.' Neither of the worms have penial setae. The position of the calciferous glands and the structure of the spermiducal glands, ally these two species to *Ocnerodrilus* as has already been pointed out; and I am disposed to form a separate genus *Kerria* for them, a genus which has been accepted by EISEN (**4**) who has added two new species to it.

The remaining Acanthodrilidae comprise about sixty species; this is not perhaps an unwieldy number to include within a single genus; and until recently all these species, that is as many of them as were known—and no new structural characters have cropped up to render a change necessary on fresh grounds—were so included. Though all these species agree with each other in the characters made use of in the definition of the family given above, there is a much greater amount of structural variation among the different species than there is for example in the genus *Perichaeta* (s. s.), and a very great deal more than in *Allolobophora* and *Lumbricus*. This of itself seems to render the subdivision of the genus *Acanthodrilus* (*sensu lato*) desirable in order to secure a uniformity of treatment for the whole group. Nevertheless, the task is not an easy one. It has been proposed at various times to form the following genera—*Trigaster* (BENHAM **3**), *Benhamia* (MICHAELSEN **13**), and *Diplocardia* (GARMAN **1**); the name *Acanthodrilus* being applied to the remaining forms not included in these genera.

The name *Trigaster lankesteri* was applied by BENHAM to an earthworm from the island of St. Thomas, differing from all the species of *Acanthodrilus*, at that time known, in the following points:—(1) the male pores enclosed by a ring surrounding a deep fossa; (2) clitellum reaching from segment xiii–xl; (3) spermathecae without diverticula; (4) three gizzards present.

Two years later MICHAELSEN proposed to include in a genus *Benhamia* those Acanthodrilidae 'which have more than one gizzard, in which the segmental organs are arranged in many tufts on the walls of the segments, and an incomplete (that is, with a ventral gutter-like space) clitellum extends beyond the male generative openings.' As this genus was considered to be merely an extension of *Trigaster*, the earlier name should, of course, have been retained, and was retained by BENHAM in his essay on the classification of the group (**1**), and by myself in a paper of similar scope (**26**). BENHAM, in the essay just referred to, defines the genus *Trigaster* (=*Benhamia*) as follows:—

'*Setae* in four couples, all on the ventral surface; individual setae of each couple close together.

'*Clitellum* occupies somites xiv–xl; complete ventrally only on the first few somites.

'*Spermiducal pores* in xviii, and *prostate pores* in xvii and xix, in a large pit or fossa, occupying the middle of the ventral surface of somites xvii to xx, the margins of which are formed by two papillae.

'*Prostates* as in *Acanthodrilus*. No penial setae.'

A number of other characters follows, inclosed in brackets which indicates that they are less easy to observe or less distinctive—i.e. more subject to variation from species to species. But

the definition, as it stands above, is really only applicable to the species *Trigaster lankesteri;* for *Benhamia rosea* HAS penial setae, and a much less extensive clitellum.

In a paper published subsequently to the one referred to above, MICHAELSEN alters his definition of the genus *Benhamia* so as to include some of the Acanthodrilidae previously described by HORST; the following species are the ones which are removed from *Acanthodrilidae*, and transferred to *Benhamia*:—*B. schlegelii, B. buttikoferi, B. beddardi*, and also ROSA'S species, *B. scioana.* The character of more than one gizzard present is thus dropped.

Later still (13), BENHAM again called attention to the generic subdivisions of the Acanthodrilidae, and proposed to retain both *Trigaster* and *Benhamia*, as well as, of course, *Acanthodrilus* itself.

The three genera are defined by the use of the following characters:—

1. *Acanthodrilus.* Gizzard single; calciferous glands present. Anterior nephridia form a compact mass, opening into the alimentary tract. Spermathecae, two pairs in vii and viii.

2. *Trigaster.* Three gizzards; no calciferous glands. Clitellum, xiii–xl. Spermathecae in viii and ix, without appendices, and opening posteriorly; no penial setae; no dorsal pores.

3. *Benhamia.* Clitellum, at most five segments; two gizzards; calciferous glands present; spermathecae in viii, ix, with appendices; penial setae present; dorsal pores present.

These definitions may be, perhaps, admitted to distinguish *Trigaster* and *Benhamia;* but *Acanthodrilus* is not correctly defined; the spermathecae of that genus lie in viii and ix, and have diverticula; the anterior nephridia do not always form 'peptonephridia.' Other characters, such as the paired nephridia, are omitted [1].

I shall now venture to give my own views with respect to the generic subdivisions of the family. Neither BENHAM nor MICHAELSEN in distinguishing their genera *Trigaster* and *Benhamia* have taken into consideration my species *Acanthodrilus multiporus* [2]. This worm (see below) has diffuse nephridia, one gizzard, dorsal pores, and no ventral gutter surrounding the male openings.

It doubtless comes nearest to *Benhamia.* This species differs from *Trigaster* and *Benhamia* in not possessing a marked median pair of folds surrounding the male pores.

If we include all the species with multiple nephridia into one genus as was originally proposed to be done by MICHAELSEN, this difficulty will be got over; the name of this genus will evidently have to be *Trigaster.* I am disposed, however, to divide those Acanthodrilidae with multiple nephridia into three genera; this will permit of the use of more than one character as a generic definition, and is, moreover, in harmony with the geographical range of the species concerned.

The genus *Benhamia* nearly restricted to the tropical parts [3] of the African continent will be defined thus:—

(1) Setae strictly paired, ventral pairs absent on segment xviii.

[1] BENHAM, however, is of opinion that in *Acanthodrilus* a network exists in addition to the paired nephridia; this is not the case with the species I have examined.

[2] See MICHAELSEN'S latest remarks (16), which I have not incorporated in the above.

[3] *Benhamia bolavi*, found in Germany, is doubtless, as MICHAELSEN thinks, an importation. So perhaps are other extra-African species.

(2) Male reproductive apertures closely approximated and placed upon a well-marked depression surrounded by a ridge; penial setae.
(3) Clitellum, xiii–xix (about).
(4) Nephridia diffuse.
(5) Two gizzards generally.

The genus *Trigaster* restricted to the West Indies is thus to be defined:—

(1) Setae strictly paired.
(2) Male reproductive openings as in *Benhamia*, but no penial setae.
(3) Clitellum, xiii–xl.
(4) Nephridia diffuse.
(5) Three gizzards.

The New Zealand species, *A. multiporus*, *A. huttoni*, *A. thomasi*, and *A. antarcticus*, may be associated to form the genus *Octochaetus* which is thus definable:—

(1) Setae in eight rows, one of two ventral setae of segments xvii, xix present.
(2) Male reproductive openings as in *Acanthodrilus;* penial setae present or absent.
(3) Clitellum, xiii–xix.
(4) Nephridia diffuse.
(5) Gizzard single.

Garman's (1) genus *Diplocardia* differs in a good many particulars from other Acanthodrilidae. The most remarkable external variation concerns the position of the spermiducal gland-pores and those of the sperm-ducts. These pores are really what they have been sometimes erroneously said to be in other Acanthodrilidae upon segments xviii–xx, instead of upon segments xvii–xix. This fact places the genus in rather an isolated position in the family, unless Perrier was correct in placing the apertures of the species described by himself in a correspondingly abnormal place. As this difference is enforced by others the genus must, I think, be allowed; the number and position of the spermathecae differs from that found in other Acanthodrilids; but these organs vary so much in other worms that it seems hardly reasonable to lay much stress on their variation in the case of *Diplocardia;* there are, contrary to what is found in all other Acanthodrilids, three pairs which are in segments vi–ix. The structure of the spermiducal glands is perhaps, next to the position of the male pore, the chief reason for considering *Diplocardia* to be a distinct generic type of Acanthodrilid. The single species of the genus—*Diplocardia communis*—is in some other respects intermediate between *Benhamia* and *Acantho-*

drilus as they are here defined; the chief resemblances to *Benhamia* lie in the absence of setae ventrally on the segment which bears the pores of the sperm-duct-pores, in the presence of two gizzards; in other respects the worm is like an *Acanthodrilus*.

There remain then those species which have paired nephridia, thirty-six in all; it is not, however, in my opinion possible to sort these into generic or subgeneric groups. Even the genus itself, to which, of course, the name *Acanthodrilus* must be applied, has, as its only positive character, the presence of paired nephridia, and of a single gizzard. The following table shows the principal structural features of the several genera:—

	SETAE.	CLITELLUM.	PENIAL SETAE.	NEPHRIDIA.	DORSAL PORES.	DORSAL VESSEL.	GIZZARDS.	SPERMIDUCAL GLANDS.	CALCIFEROUS GLANDS.	LOCALITY.
Acanthodrilus	paired or distant; 8	xiii–xvi (xx)	+, rarely o	paired	+ or o	single or double	one or absent	tubular	absent or in xiv–xviii (some)	New Zealand; Australia; Cape, Kerguelen; S. America
Benhamia . .	paired; 8. absent on xviii	xiii–xix (xxii)	+, rarely o	diffuse	+ or o (?)	single	two	tubular	three in xiv–xvi	Africa; Java; W. Indies
Trigaster . .	paired; 8	xiii–xl	o	diffuse	o	single	three	tubular	o	W. Indies
Diplocardia .	paired; 8 absent on xviii	xiii–xviii	small	paired	+	double	two	tubular, with indications of lobate structure	o	N. America
Octochaetus .	distant; 8	xiii–xvii (xx)	small	diffuse	+	completely double	one	tubular	xiv–xvii (some)	New Zealand
Deinodrilus .	distant; 12	xiv–xvi	+	diffuse	?	completely double	one	tubular	o	New Zealand
Plagiochaeta .	paired; 54	xiv–xviii	+	paired	o	single	rudimentary	tubular	xiv	New Zealand
Kerria . . .	paired; 8	xiii–xix	o	paired	o	single	one	tubular, lined with a single layer of cells	ix	S. America

Genus **Acanthodrilus**, Perrier.

Syn. **Mandane**, Kinberg.

Lumbricus, Grube (in part.).

Hegesipyle[1], Kinberg.

Definition. **Acanthodrilidae, with paired nephridia, the external pores of which either alternate in position from segment to segment, or, if fixed, are in front of one of the lateral couples of setae. Gizzard single. Calciferous glands present or absent. Clitellum, XII (XIII)–XVI (XIX); no genital fossa. Penial setae rarely absent.**

[1] *Fide* Perrier.

This is by far the most extensive of the genera of Acanthodrilidae; it comprises eighteen well-marked species, besides a few others, of which we have not at present sufficient knowledge, and which, indeed, may not belong to *Acanthodrilus* (s. s.) at all.

To the latter category belong *Hegesipyle hanno*, of KINBERG, which PERRIER has determined (6) to be an *Acanthodrilus; Mandane stagnalis*, KINBERG, no doubt a true *Acanthodrilus*, since this is the only genus of the family which occurs in S. America; *Lumbricus kerguelarum*, GRUBE, has been shown by MICHAELSEN (10) to be referred to the Acanthodrilidae, and is perhaps synonymous with LANKESTER'S *A. kerguelenensis*. Finally, we have several species of '*Lumbricus*' described by HUTTON (1), which are, no doubt, as HUTTON himself pointed out later (3), referable to the genus *Acanthodrilus* (*sensu lato*); probably most of these species are identical with those subsequently described by myself from New Zealand.

The identity of *Mandane* with *Acanthodrilus* was suspected by PERRIER (3) and afterwards (6) proved; the name, however, cannot stand, as KINBERG used the same name in the same paper for a genus of Polychaeta[1]; neither can *Hegesipyle*; for, although PERRIER has shown it to be an *Acanthodrilus*, it is not clear whether it is referable to this genus in the strict sense.

The species of the genus *Acanthodrilus* vary in size from an inch or so to twelve inches and upwards. It is one of the few genera which comprises aquatic as well as terrestrial forms. *A. dalei* and *A. aquarum dulcium* (see BEDDARD [43]) occur in streams in the Falkland Islands and '*Mandane*' *stagnalis* was obtained from a pond near Montevideo. *A. schmardae* occurs in fresh water in Queensland. The *prostomium* shows differences which are usually, in other families of Oligochaeta, correlated with a sufficient number of other differential characters to be of generic value. In some species (e. g. *A. novae-zelandiae*) the prostomium is prolonged backwards so as to completely divide into two the buccal segment; in others it is not prolonged back so far or is merely a projection, separated from it of course by a groove from the buccal segment.

The *setae* again show no such constancy of arrangement as is commonly met with in a single genus. In some species the individual setae of each couple are very close together; in others they are not. In *A. capensis* we have the intermediate condition; the two setae of each couple are closely approximated anteriorly, wider apart posteriorly. In *A. falclandicus* the lateral setae are further apart than the ventral setae.

Apart from the paired nephridia and the single gizzard there are no very salient differences between *Acanthodrilus* and *Benhamia*. I have noticed, however, that in *Benhamia* the calciferous glands are very distinct from the oesophagus; they have the shape of reniform pouches, attached to the sides of the oesophagus. As a rule,

[1] This extraordinary departure from the usual laws of nomenclature was first pointed out by PERCIVAL WRIGHT. Zoological Record, vol. iii. p. 597, footnote.

moreover (? always), there are three pairs of them in segments xiv, xv, and xvi. In *Acanthodrilus*, on the other hand, the calciferous glands present the appearance of swellings of the oesophagus; they are commonly fewer than three pairs, and they are often (as in *A. georgianus* and *A. ungulatus*) completely absent. In all the species of *Acanthodrilus* which I have myself examined with reference to this point, viz. *A. novae-zelandiae*, *A. dissimilis*, *A. smithii*, *A. ungulatus*, *A. capensis*, *A. pictus*, *A. georgianus*, *A. falclandicus*, and *A. aquarum-dulcium*, the ventral setae of segment xviii are present. In *Benhamia crassa*, *B. stuhlmanni*, and *B. whytei* these setae are absent; whether this is a character of generic value remains to be seen.

That the Acanthodrilidae with a diffuse nephridial system are near to those with paired nephridia is shown by the difficulty of getting characters other than this for distinguishing the genera. Furthermore there are special characters, confined to a very few species of Acanthodrilidae, which occur indifferently in members of more than one genus. The most striking example of a structure such as I refer to is the existence of the copulatory setae (as Horst terms them) and glands in the neighbourhood of the spermathecae in *Benhamia beddardi*, and in *A. ungulatus* and *A. schmardae*. So also the double dorsal vessel—completely double—characterizes the earlier genus *Octochaetus* (three species) and *Diplocardia communis*. The 'peptonephridium,' so characteristic of *Octochaetus*, is also met with in *A. annectens*, *A. paludosus*, *A. littoralis*, and the genus *Trigaster*.

The South American species form a more or less marked group; as compared with the New Zealand species indeed a well-marked group. They are *all* of small or moderate size. The clitellum is not extensive—xiii–xvi or xvii. Dorsal pores are usually wanting. The only species of *Acanthodrilus* with no more than a single pair of testes and vasa deferentia occur in this group. The dorsal vessel is invariably single. Calciferous glands are absent as specialized structures in all the species in which they have been carefully looked for, the vascular and much plicated walls of part of the oesophagus doing duty for them. If it were not for the Australian species I should be disposed to emphasize the above characters by separating off the Patagonian, Argentine, and Chilian Acanthodrilidae as a genus. The Australian species, however, are all of them so imperfectly known that it would be, in my opinion, unwise to attempt any such division of the genus *Acanthodrilus*. For *A. macleayi* has a clitellum comprising, as in the South American species, a small number of segments, while *A. australis* agrees with the New Zealand species in having a more extensive clitellum (xiii–xix).

The New Zealand species of *Acanthodrilus* nearly all agree to differ from the species found elsewhere in that the nephridia are alternate in position. The only

exceptions are *A. annectens* and its near ally, *A. paludosus*—a species which recalls in some particulars the genus *Octochaetus*. It is indeed a question whether they should not be incorporated in that genus.

The following are the points in which the two species in question resemble the genus *Octochaetus*:—

(1) The great prominence of the papillae bearing the atrial pores.

(2) The completely double dorsal vessel[1].

(3) The presence of an anterior peptonephridium.

(4) The attachment of the gonads to the posterior wall of the segment.

The arrangement of the setae is also somewhat similar, but as in species which are undoubtedly members of the genus *Acanthodrilus* (s. s.), such as *A. georgianus*, &c., the setae are disposed in the same fashion, the resemblance is obviously of less weight. In the two species above-mentioned the nephridia are paired, as in other *Acanthodrilus;* but the muscular end sac so universal in *Acanthodrilus* is here absent. There is thus a slight approximation to the diffuse nephridia of *Octochaetus*. A final indication of affinity between *A. annectens* and *A. paludosus* on the one hand and the genus *Octochaetus* is possibly afforded by the sperm-ducts which run in the thickness of the body-walls. But as this also occurs in *A. communis* the resemblance is perhaps less noteworthy.

The table printed on pp. 532 and 533 will serve for the discrimination of the species. I include the species of *Octochaetus* and *Diplocardia*.

Two out of the three species described by PERRIER appear to me to be hardly recognizable; this is hardly the fault of the describer, for he characterized them sufficiently to enable them to be separated from each other; there are not, however, enough points dealt with to fix their position with anything like certainty in the present state of our knowledge of the genus; it is certain, though, that they are all members of the family Acanthodrilidae. One of these species is, I believe, as was first pointed out by HORST, identical with that named provisionally *A. layardi* by myself (9). I now give some notes about the two remaining forms.

(1) *A. obtusus*. This is a large worm, measuring about 700 mm. The male pores are said to be on the nineteenth and twenty-first segments. Penial setae ornamented with spinelets. Dorsal pores are present. Nephridia paired. A single gizzard in segments vii–ix. A pair of organs which seem to be most probably the sperm-sacs are present in the twelfth segment (the thirteenth is mentioned, but this seems most likely to be an error). It is suggested that they are the ovaries, but, although the segment which contains them bears out this suggestion, the sketch given is more like a pair of sperm-sacs. The spermathecae have no diverticula. The worm is from New Caledonia. The difficulty which prevents me from placing this species in the genus *Acanthodrilus* as here defined is, of course, the position of the male pores. Had it not been for the existence of the American *Diplocardia*, I should have been tempted, in spite of PERRIER'S accuracy in description,

[1] Not, as in *A. novae-zelandiae*, single where it traverses the septa.

to have assumed an error of two segments; but it will be noted that in the figure illustrating the anatomy of the species (3, Pl. ii, fig. 17) the organs in question are placed in exactly the same segments as they occupy in the description. The huge size of the species prevents me from identifying it with any known species of *Acanthodrilus*, and, on the whole, I think it safer to leave it in the category of a '*species inquirenda*.'

(2) *A. verticillatus*. This worm is placed by PERRIER in the genus *Acanthodrilus*, with a little doubt, as the sexual apparatus in the individual which he studied was reduced to the four sacs of penial setae. The length of the specimen was 350 mm. The setae are paired. The penial setae are upon the seventeenth and eighteenth segments. There is a gizzard. Attached to each sac of penial setae is a gland. I think that, from PERRIER'S description, there is no doubt that the worm is a member of the genus *Kynotus*, but, as this identification cannot be regarded as certain, I leave it, for the present, among the Acanthodrilidae '*incertae sedis*.'

The above two species are the only two species named '*Acanthodrilus*' about whose position in the system there is great doubt; I think that ROSA has correctly referred KINBERG'S *Mandane stagnalis* to his species *A. spegazzinii*, which will be considered later (see below).

(1) Acanthodrilus dissimilis, BEDDARD.

A. dissimilis, BEDDARD, P. Z. S., 1885, p. 813.

A. neglectus, BEDDARD, P. Roy. Soc., Ed. xiv, p. 156.

Definition. *Length*, 143 *mm.; breadth (at clitellum)*, 4·5 *mm.; number of segments*, 225. *Clitellum, XIV–XIX; segments, XVII–XIX, with a ventral non-glandular area. Male pores connected by a straight longitudinal groove. Prostomium completely divides buccal segment. Setae paired. Dorsal pores visible in posterior region of body only. Gizzard in VI; calciferous glands in XV, XVI; in XIV oesophagus somewhat more globular than in preceding segments, but this dilatation is not comparable in size to the calciferous glands of XV, XVI. Intestine begins in XX. As the oesophagus gradually widens out to form intestine, it is difficult to state precisely where the latter begins. The third to the eighth septa after the gizzard are thickened. Hab.—New Zealand*[1].

The remaining characters agree with those of *A. parkeri*. The spermathecae are of the same form, but I never observed more than two diverticula to each.

The differences between this species and *A. parkeri* are evidently but slight. The main difference is really one of size. The position of the gizzard, however, seems to distinguish the two species, as also the greater number of thickened septa in *A. parkeri*. On further consideration I reunite with the present species *A. neglectus* which I formerly separated. The differences between the two forms are limited, so far as I was able to ascertain, to a difference in the position of certain papillae in the anterior region of the body. At most, as it now appears to me, this difference is of value in establishing a variety. BENHAM has united the two species.

[1] For notes on colour, locality, &c., of this and other New Zealand species, see W. W. SMITH (2).

	SETAE.	CLITELLUM.	PROSTOMIUM.	GIZZARD.	NEPHRIDIA.	CALCIFEROUS GLANDS.
A. novae-zelandiae . .	paired	xiv–xix	complete	vi, viii	paired alternate	none distinct
A. annectens	”	xiii–xx	incomplete	v	paired	none
A. paludosus . . .	”		”	v, vi	”	”
A. multiporus . . .	distant	”	”	”	diffuse	xvii or xviii
A. antarcticus . . .	distant		complete		”	x
A. dissimilis	paired	xiv–xix		”	paired alternate	xv, xvi
A. parkeri	”	xiii–xix	”	vi, vii		xiv–xvi
A. smithii	”	”	”	v, rudimentary	”	
A. huttoni	distant	xiii–xix (xx)	incomplete	v	diffuse	xv, xvi
A. thomasi	”	xiii–xix	”	v, vi	”	xvii
A. plumbeus	3-4 > 1-2	xii–xix	complete	vi	paired alternate	xiv, xv
A. pictus	paired	xiii–xvii	incomplete	”	paired	none
A. decipiens	distant	”	complete	” (?)	”	”
A. hilgeri	paired	xiv–xvi	”	present in viii–x	”	?
A. occidentalis . . .	”	?	”	vi	”	none
A. australis	”	xiii–xix	incomplete	”	”	?
A. magellanicus . . .	distant	xiii–xvii		”	”	none
A. ungulatus . . .	paired	xiii–xvii	complete	vi, vii	”	
A. platyurus	distant behind, paired in front	”	”	v, vi	”	absent ”
A. minutus	paired	xiii–xvii	”	vi (?)	”	”
A. bicinctus	”	xiii–xvi	incomplete	”	”	?
A. schmardae . . .	”	xiii–xviii	?	present	”	absent
A. purpureus . . .	”	xiii–xvi	incomplete	vii	”	
A. dalei	”	?	complete	vi, vii	”	”
A. chilensis	paired in front	xiii–xvi	”	”	”	
A. capensis	distant		incomplete	present	”	
A. kerguelarum. . .	”	”	”		”	”
A. communis . . .	paired	xiii–xviii	”	two in vi and vii	”	”
A. cingulatus . . .	”	xiv–xviii	complete	vi, vii	”	”
A. littoralis	distant	xiii–xvii	incomplete	present	”	”
A. putablensis . . .	distant behind, paired in front	xiv–xvi	complete	vi	”	”
A. bovei	distant, 3-4 > 1-2	xiii–xvi	incomplete	rudimentary	”	”
A. georgianus . . .	distant	”	”	absent	”	”
A. carneus	”	”	complete	vi	”	”
A. falclandicus . . .	distant, 3-4 > 1-2	”	incomplete	rudimentary in v	”	”
A. aquarum dulcium .	”	”	”	”	”	”
A. rosae	paired	xiv–xix	complete	vi, vii	”	xiv, xv
A. macleayi	”	xii–xvi(xvii)	incomplete	present	”	
A. monocystis . . .	”	xiii–xvii	complete	vi	paired alternate	?
A. valdiviensis . . .	distant	xiv–xvii	incomplete	v, vi	paired	

INTESTINE BEGINS.	DORSAL VESSEL.	LAST HEARTS.	SPERM SACS.	PENIAL SETAE.	OTHER STRUCTURES.
xviii	double	xiii	xi, xii	not ornamented	
	”	”			peptonephridium ; gonads on posterior walls of segments ; sperm-ducts imbedded in body-wall
xx	”		ix, xi, xii	absent	peptonephridium ; anal nephridia on posterior wall of xiii ; gonads
xix	”	”	xi, xii	present	
	”			”	
xx	single	”	”	not ornamented	
xviii	”	”	”	”	
”	”	”	”	”	
”	double	xii		absent	
xix	”	xiii	”	?	
	”	”	”	ornamented	
xvii	single	xii	ix, x, xi	not ornamented	a single pair only of gonads in x ; no dorsal pores
?	”	?	?	”	
	? ”		ix, x, xi	absent	
xvii	”	xiii	xi, xii	not ornamented	
			x, xi, xii	”	
	”	xii	xi, xii	ornamented	
xix	”	xiii	x, xi, xii	”	copulatory setae in neighbourhood of spermathecae
	”	”	ix, xi	”	a single pair of testes in x
xvii	”		xi	not ornamented	testes in x only
?	”		”	ornamented	” ”
	”			not ornamented	copulatory setae and glands
	”	xii		ornamented	
	”	”	ix (? x), xi	”	
	”	”	xi	”	
xvi or xvii	”	xiii	ix, x, xi, xii	”	
			x, xi, xii	”	
xvii	double	xii	”	present	sperm-duct imbedded in body-wall ; three pairs of spermathecae
	single			ornamented	testes in x only
”	? ”	”	xi	”	no dorsal pores ; only a single pair of testes and vasa-deferentia (in x) ; peptonephridium present (?)
	”	xiii	ix, xiii	”	
				”	genital papillae in ix, x, xi
	”		xi, xii	”	genital papillae on x ; no dorsal pores
	”	xii	ix, xi	not ornamented	testes in x only
xvi	”	xiii	xi, xii	ornamented	genital papillae on x ; no dorsal pores
	”	xii		”	genital papillae on xviii, xx ; no dorsal pores
	double	xiii		not ornamented	
?	single ?	?		ornamented	
xv	double			”	only one pair of spermathecae and spermiducal glands
xvii	single	xii	ix, xi	”	

(2) Acanthodrilus parkeri (NEW SPECIES).

Definition. *Length,* 184 *mm.; breadth (at clitellum),* 9 *mm.; number of segments,* 185. *Clitellum, XIII–XIX* (?). *Male pores on very slightly prominent papillae, corresponding to ventral pairs of setae, those of each side connected by a straight longitudinal groove. Prostomium complete. Setae paired. Dorsal pores visible in posterior region of body only. Gizzard rather elongated in VI, VII; calciferous glands in XIV, XV, XVI; the two last pairs much the largest. Intestine begins in XVIII, typhlosole inconspicuous. Ten septa following the gizzard are thickened, particularly the second and the next six. Nephridia paired and alternate. Dorsal vessel single; four pairs of hearts are in X–XIII. Sperm-sacs in XI, XII, flattened and oval. Penial setae stout and curved like an ʃ; extremity thick and blunt without any ornamentation. Spermathecae, each with two well-marked diverticula of a mulberry-like appearance; occasionally three diverticula present. Hab.—New Zealand.*

(3) Acanthodrilus novae-zelandiae, BEDDARD.

A. novae-zelandiae, BEDDARD, P. Z. S., 1885, p. 813.

Definition. *Length,* 280 *mm.; breadth (at clitellum),* 10 *mm.; number of segments,* 240 *(about). Clitellum, XIV–XIX; a median area lies between ventral setae from segment XVI onwards. Male pores corresponding to ventral pairs of setae, those of each side connected by a straight longitudinal furrow, which passes exactly between two setae of segment XVIII. Prostomium complete. Setae paired. Dorsal pores in posterior region of body. Body square in outline posteriorly with sloping sides; setae implanted at the angles. Gizzard in VI, VII; calciferous glands hardly developed, but walls of oesophagus in XIII–XVI thick and vascular. Intestine begins in XVIII, typhlosole slight. First septum in front of gizzard separating V/VI; this and following segment which embraces the gizzard at about the middle, thin and membranous. The ten following septa thickened, particularly those separating segments IX/XVI. Nephridia paired and alternate. Dorsal vessel double, the two tubes uniting temporarily when they traverse the septa; hearts in X–XIII. Sperm-sacs in XI, XII. Spermathecae with a single mulberry-like diverticulum, often lying in front of the septum, behind which lies the pouch. Penial setae not ornamented. Hab.—New Zealand.*

(4) Acanthodrilus rosae, BEDDARD.

A. Rosae, BEDDARD, Q. J. M. S., vol. xxx, 1890, p. 434.

Definition. *Length,* 250 *mm.; breadth,* 10 *mm.; number of segments,* 236. *Colour dark*

brown (in alcohol) verging towards purple on the dorsal surface. Clitellum, XIV–XIX, not developed ventrally upon XVII–XIX. Male pores upon inconspicuous papillae; the two pores of each side connected by a longitudinal groove. Prostomium completely divides buccal segment. Dorsal pores not seen. Setae paired. Gizzard in VI, VII; calciferous glands in XIV, XV. Intestine begins in XVIII. Septa X/XV slightly thickened. Dorsal vessel as in A. novae-zelandiae; *so too hearts. Nephridia paired and alternate. In neighbourhood of pharynx are well-developed blood-glands. Spermathecae with diverticulum terminating in a mulberry-shaped extremity. Hab.—New Zealand.*

This species might be confused with *A. novae-zelandiae*, but for two points of difference: (1) the absence of any greatly thickened septa; (2) the stalked character of the spermathecae diverticulum.

(5) Acanthodrilus monocystis (BEDDARD).

Neodrilus monocystis, BEDDARD, P. Roy. Soc. Ed., vol. xiv, p. 157.

Definition. *Length,* 70 *mm.; diameter,* 5–6 *mm.; number of segments,* 155. *Setae strictly paired. Prostomium completely divides buccal segment. Clitellum, XIII–XVII, saddle-shaped. Gizzard in VI; intestine begins in XV, and has no typhlosole. No specially thickened septa. Last heart in segment XIV. Nephridia alternate. Sperm-sacs in X–XII. One pair of spermiducal glands opening on to XVII, and continued back by a groove on to the following segment; penial setae beset by minute asperities distally. Spermathecae, one pair in VIII, with a very large diverticulum lying in segment in front. Hab.—New Zealand.*

I have come to the conclusion that it is not permissible to retain the genus *Neodrilus* for this species, in spite of its possessing only one pair of spermiducal glands. The species has been investigated, not only by myself, but, in some respects more fully, by BENHAM (**19**). The latter paper contains a good series of illustrations. The species evidently comes nearest to *A. dissimilis*, but it is more slender in appearance, and quite unmistakable, even before dissection.

(6) Acanthodrilus smithii, BEDDARD.

A. smithii, BEDDARD, P. Z. S., 1892, p. 675.

Definition. *Length,* 75 *mm.; diameter,* 3 *mm.; number of segments,* 114. *Colour (of preserved specimens), violet above. Prostomium completely divides buccal segment. Setae strictly paired, dividing body into equal areas. Clitellum, XIII–XIX, saddle-shaped.*

Dorsal pores absent (?). *Gizzard, rudimentary, lying in V; in XIV, XV oesophagus dilated to form rudimentary calciferous glands; intestine commences in XVIII. Nephridia alternate in position. Dorsal vessel single; last heart in XIII. Sperm-sacs in IX–XII. Spermathecae with three diverticula, of which one is constantly in front of the septum, behind which lies the pouch. Penial setae bifurcate at tip, with two delicate wing-like processes, smooth. Hab.—New Zealand.*

This species contrasts strikingly with the remaining New Zealand species by its strong pigmentation.

(7) Acanthodrilus litoralis (Kinberg).

Mandane litoralis, Kinberg, Öfv. Svensk. Akad., 1866, No. 4, p. 100.
? **Mandane patagonica**[1], Kinberg, loc. cit., p. 100.

Definition. *Length,* 100 *mm.; diameter,* 6 *mm.; number of segments,* 120. *Prostomium, prolonged over half of buccal segment. Clitellum, XIII–XVII; complete sacs for a non-glandular area on last two segments. Setae in four double series, but individual setae some way apart. Nephridiopores in front of third seta, commencing in segment VII (at latest). Male pores corresponding in position to ventral setae. Sperm-duct pores on XVIII, between setae* 1 *and* 2. *No dorsal pores. Spermathecal pores in front of third seta. Gizzard present; intestine begins in XVII. Sperm-sacs only one pair, in XI, to which correspond a single pair only of sperm-duct funnels in X. Last hearts in XII. Spermathecae two pairs in VIII, IX; diverticulum single, with a branched lumen. Penial setae ornamented with variously sized spines. Hab.—Straits of Magellan; near the shore.*

A peculiarity of this species, according to Rosa (6), is the possession of certain glands which he terms 'ghiandole filatrici.' They occur in the anterior segments, on the anterior face of the septa, but no apertures were discovered. They are compared to the tufts of nephridia which occur in a similar situation in *Trigaster lankesteri*, and to the 'Spinndrüsen' of the Capitellidae[2]. They may perhaps be also compared to the specially dense mass of nephridia which occur in the Perichaetidae in a few of the anterior segments. More likely, perhaps, they are 'peptonephridia,' like those of *A. annectens*, &c.

[1] The query is that of Rosa.

[2] H. Eisig, Die Capitelliden, Fauna u. Flora des Golfes v. Neapel, xvi, p. 324. The resemblance in the secretion (bundles of filaments) of the glands in the *Acanthodrilus* and in the Capitellidae is very remarkable.

(8) Acanthodrilus hilgeri (Michaelsen).

Mandane Hilgeri, Michaelsen, SB. Hamb. wiss. Anst., vi, 1889, p. 8.

Definition. *Length,* 95 *mm.; diameter,* 3 *mm.; number of segments,* 93. *Colour, in alcohol, grey violet above. Prostomium completely divides buccal segment. Clitellum, XIV–XVI, complete. Setae strictly paired. Nephridiopores in front of dorsal setae. Male pores corresponding to ventral pair of setae. Gizzard in segments VIII, IX, X. Spermathecal pores in front of ventral pair of setae. No penial setae, the ordinary setae being present. Sperm-sacs in IX–XI. Spermathecae, with a single diverticulum longer than the pouch. Hab.—Corral, Chili.*

(9) Acanthodrilus pictus (Michaelsen).

Mandane picta, Michaelsen, loc. cit., p. 5.

Definition. *Length,* 132 *mm.; breadth (at clitellum),* 8 *mm.; number of segments,* 135. *Segments not marked by annuli. Colour (in alcohol), brown; after clitellum a broad purplish brown band, limited by dorsal setae, appears on dorsal surface. Clitellum, XIII–(XIV)–XVII, undeveloped ventrally. Male pores on slightly prominent papillae, in a line with outer seta of ventral couple; Sperm-duct pores slightly dorsal of these. Prostomium continued by grooves about half-way over buccal segment, after a groove which divides buccal segment into two halves. Setae in couples, upon prominent papillae; those of ventral couple nearer to each other than dorsal, especially behind clitellum. Dorsal pores absent. Gizzard in VI; in XV oesophagus becomes wider, and has a much-folded lining membrane; this is the equivalent of calciferous glands. Intestine begins in XVII. First septum lies in front of gizzard, i.e. V/VI. Anterior septa not much thickened; those between XI/XII, XII/XIII most. Dorsal vessel single; hearts in X, XI, XII. Nephridia paired, opening in front of dorsal setae; the muscular terminal sac of nephridium has a short caecum. A single pair only of sperm-duct funnels in X; the sperm-sacs are in IX, XI, racemose in character. Spermiducal glands not very long; penial setae flattened, and widened out just before pointed free extremity, not ornamented. Spermathecae with large diverticulum. Hab.—Rio Bruno, S. Chili; Corral, Valdivia.*

Michaelsen places the sperm-sacs in segments x, xi; I think, however, that the 'sperm-sac' of segment x is a sperm-reservoir. The above description is mainly taken from my own notes.

(10) Acanthodrilus valdiviensis (NEW SPECIES).

Definition. *Length,* 65 *mm.; diameter,* 5 *mm.; number of segments,* 99. *No integumental pigment visible in alcohol specimen. Prostomium extends over about half of buccal segment. Clitellum extends over XIV–XVII, complete except on XVII. Setae not strictly paired, dorsal a little further apart than ventral. Groove connecting male pores passes to outside of ventral setae of segment XVIII. Oviducal pores in front of and to inside of ventralmost setae. Last pair of hearts in segment XII. The gizzard is in segments V, VI; intestine commences in the middle of segment XVII. The septa dividing segments VII/XVII are thickened. The nephridia have a distinct caecum. One pair of rosettes and testes in X; sperm-sacs in IX, XI; sperm-reservoirs in X. Spermathecae with very large diverticulum. Penial setae with pointed hooked extremity, just behind which they are somewhat swollen; behind this again the setae are marked with denticulate ridges. Hab.—Corral, Valdivia (Mr. A. Lane).*

(11) Acanthodrilus dalei, BEDDARD.

A. Dalei, BEDDARD, Q. J. M. S., vol. xxx, 1890, p. 433.

Definition. *Length,* 40 *mm.; diameter,* 4 *mm.; number of segments,* 77. *Prostomium completely divides the buccal segment. Clitellum XIII–XVII. Setae strictly paired. Nephridiopores in front of dorsal pair of setae. Sperm-sacs in IX, XI. Gizzard in segments VI and VII, the intersegmental septum being present. Penial setae with a few denticulations near to free end, which is expanded. Spermathecae with a single large diverticulum as big as pouch. Hab.—Falkland Islands; in fresh water.*

The violet-red colour of this species and its complete prostomium sufficiently distinguish it from its allies.

(12) Acanthodrilus platyurus, MICHAELSEN[1].

A. platyurus, MICHAELSEN, Arch. f. Nat., 1892, p 226.

Definition. *Length,* 180 *mm.; breadth,* 7 *mm.; number of segments,* 150. *Prostomium complete. Clitellum, XIII–XVII, saddle-shaped. Colour during life, 'flesh-coloured, clitellum clear brown.' Male-pores upon circular papillae connected by grooves in the*

[1] As MICHAELSEN's single specimen was 'sehr stark erweicht,' and, therefore, necessarily very difficult to interpret, I have not hesitated to expand his description in accordance with my results obtained from the study of other specimens.

way common among the Acanthodrilidae, opening in line of ventral setae. Setae anteriorly in four pairs, the ventral setae on the first segments being a little further apart than the lateral; towards the genital orifices these setae become more approximated. In the posterior region of the body the setae of each couple are a little more separated. Dorsal pores visible behind clitellum. Gizzard in V, VI; calciferous glands absent. One pair of papillae on XX on a line with ventral setae. A pair of funnels in X. Sperm-sacs in IX, XI, racemose. Penial setae much curved at extremity and ornamented with numerous forwardly directed spinelets. Spermathecae apparently without diverticula, but these are possibly represented by the thick circular swelling at the base of each, opening in line with ventral setae. Hab.—Estancilla, Valdivia, Chili.

(13) Acanthodrilus capensis, Beddard.

A. capensis, Beddard, P. R. Phys. Soc., 1885–6, p. 369.

Definition. *Length, about* 80 *mm. Setae: in the anterior region of body ventral setae form a closely approximated couple, while the two lateral setae are much further apart; posteriorly (after the male generative pores) the ventral setae get further apart, but are not so widely separated from each other as the lateral setae. Gizzard present; intestine begins in XVI or XVII. Male pores corresponding to interval between two ventral setae, which latter are wanting. Sperm-duct pore to outside of ventral setae. Oviducal pores in front of lower setae of ventral couples. Last heart in XIII. Spermathecae with a single small diverticulum opening to outside of outermost setae of ventral couple. Sperm-sacs in segments IX–XII. Penial setae beset with numerous forwardly directed spinelets. Hab.—Cape Colony.*

This species is very active in its movements like *Perichaeta*. My original description of it is clearly inaccurate in some particulars, as I pointed out later (**9**). The above probably requires revision in the location of some of the organs. In some specimens examined there were a number of genital papillae; in one as many as six pairs on segments vii–xii.

(14) Acanthodrilus kerguelarum (Grube).

Lumbricus kerguelarum, Grube, MB. k. Akad. Wiss., Berlin, 1877, p. 552.

A. kerguelarum, Michaelsen, Arch. f. Nat., 1891, p. 226.

A. kerguelenensis, Lankester, Phil. Trans., vol. 168 (extra vol.), p. 264.

Lumbricus (Dendrobaena) kerguelarum, Vaillant, Annelés, p. 167.

Definition. *Length,* 38–47 *mm.; number of segments,* 92. *Prostomium round, imbedded in, but not continued by grooves on to buccal segment. Setae in eight rows, those of ventral pair approach each other more closely in segments XVI–XIX. Clitellum, XIII–XVI, complete. Spermathecae each with two diverticula. Sperm-sacs three pairs in X–XII, the last pair racemose, the others not so. Penial setae with numerous small spines—the apices directed forwards—on free extremity. Hab.—Kerguelen, Marion Island.*

That *Lumbricus kerguelarum* of GRUBE was in all probability an *Acanthodrilus* was first pointed out by myself (**41**, p. 301, footnote). VAILLANT, nevertheless, ranged it (**6**, p. 167) in the genus *Lumbricus*, though certainly putting the species among 'Lumbrici dubii.' GRUBE's description is given in full, and it is curious that VAILLANT did not suspect that the 'papillae' of the seventeenth and nineteenth segments, were, as I suggested, the male pores; VAILLANT did, however, go so far as to suggest that the worm might belong to the intraclitellian group of PERRIER. The justice of my own suggestion was confirmed later by MICHAELSEN who examined the types. MICHAELSEN considered that the species was not identical with LANKESTER's *A. kerguelenensis;* this opinion was chiefly based upon differences in the shape of the penial setae, which seem to me to be too slight for recognition.

I have examined a single specimen evidently referable to the same species, which was collected during the voyage of H.M.S. 'Challenger' on Marion Island. I have, therefore, been able to fill up a few lacunae in the previous descriptions, which are incorporated in the above definition. This species comes, perhaps, nearest to *A. capensis*, but is to be distinguished from it by the arrangement of the setae.

(15) Acanthodrilus georgianus, MICHAELSEN.

A. Georgianus, MICHAELSEN, JB. Hamb. wiss. Anst., v, 1888, p. 68.

Definition. *Length,* 60 *mm.; diameter,* 5·5 *mm.; number of segments,* 87. *Prostomium prolonged over two-thirds of buccal segment. Clitellum, XIII–XVI, incomplete on last two segments. Setae four pairs, but the individual setae are at some distance from each other; posteriorly the setae are separated by equal intervals; anteriorly there is a tendency to a paired arrangement. No dorsal pores. Nephridiopores in front of interval between setae* 2 *and* 3, *but nearer to latter. No gizzard; typhlosole completely absent. Sperm-sacs in XI, XII. Spermathecae two pairs in VIII, IX; each with two diverticula. Penial setae with a few blunt tubercles on free extremity. Hab.—South Georgia.*

The sperm-sacs are said by MICHAELSEN to arise as a number of separate spherical

or pear-shaped saccules which ultimately fuse to form a single racemose sperm-sac on each side of gut in segments xi, xii. The spermiducal gland has a remarkably fine lumen. There is apparently a tendency for the glandular cells of its walls to be gathered into separate masses (see p. 118).

(16) Acanthodrilus falclandicus, BEDDARD.

A. georgianus, BEDDARD, Q. J. M. S., vol. xxx, 1890, p. 421.
A. falclandicus, BEDDARD, P. Z. S., 1892, p. 678.

Definition. *Length about 75 mm. Setae in eight rows, distance separating lateral setae greater than that separating ventral. Prostomium extending on to buccal segment for about one half the diameter. Clitellum, XIII–XVI, complete. No dorsal pores. Gizzard rudimentary in V; intestine begins in XVI and has a rudimentary typhlosole. Last heart in XIII. Sperm-sacs in XI, XII; median sperm-reservoir in IX–XV. Penial setae of two kinds, some smooth, some ornamented; the later with a number of serrated tubercles at free end. Hab.—Falkland Islands.*

I originally confounded this species with MICHAELSEN'S *A. georgianus.* MICHAELSEN, however, in a paper published subsequently to the one in which he first described the species, pointed out the main differences, most of which are indicated in the descriptions of the two species given above. In addition to these I may mention that in *A. falclandicus* the nephridiopores are directly in front of the third setae. In my definition of *A. georgianus* I have not referred to the existence of smooth as well as ornamented penial setae; these are, however, figured by MICHAELSEN (**15**, Pl. ii, fig. 4 *c*), but he has expressed the opinion that the smooth setae are so because they are immature. I do not think this myself or I should emphasize this as a further difference between the species. *A. georgianus* seems to want the median sperm-reservoir of the present species, as well as the septal sacs ('glycogenic organs'). MICHAELSEN has suggested that *A. falclandicus* is synonymous with ROSA'S *A. bovei.* There is, I have pointed out (**57**, p. 679), no doubt that they are near to each other; but not, I think, identical. As, however, ROSA'S description is, on account of the poorness of his specimens, in some respects defective, it is not easy to be quite certain. In the meantime *A. bovei* is a much smaller species; the tubercles on the penial setae are not stated to be denticulate as they are in *A. falclandicus;* the clitellum of *A. bovei* has, as is the case with *A. georgianus,* a median non-glandular area on segments xv, xvi. In *A. falclandicus,* however, the same space may be occasionally seen, so that this character is not likely to

distinguish the species. The apparent differences in the genital papillae are of less weight, as there is much variation in these structures.

(17) Acanthodrilus aquarum-dulcium, BEDDARD.

A. aquarum-dulcium, BEDDARD, P. Z. S., 1892, p. 680.

A. georgianus, BEDDARD, Q. J. M. S., vol. xxx, 1890, p. 421 (in part.).

Definition. *Length,* 47 *mm.; diameter,* 3 *mm.; number of segments,* 90. *No specially thickened septa. Penial setae with a series of minute denticles at free end. In other respects like* A. falclandicus. *Hab.—Falkland Islands; in fresh water.*

I originally confounded this species with *A. falclandicus*, or, as I then called it, (erroneously) '*georgianus*.' Later its differences from that species were pointed out; there can be, I think, no doubt of its distinctness. The chief difference is in the form of the penial setae. The worm also is of a much more slender build than *A. falclandicus*, which has possibly something to do with its aquatic habit. I have not used the papillae as differential characters as these structures are so apt to vary that they must be used with the greatest caution, and, indeed, I have endeavoured never to rely entirely upon them. In specimens of this species examined as transparent objects in glycerine, there were to be seen two pairs of papillae lying between the ventral setae on each of segments xviii, xx—a pair to each that is to say. This species may also differ—but this is perhaps very doubtful—from the last in the fact that it has egg-sacs which I did not observe in *A. falclandicus*.

(18) Acanthodrilus bovei (ROSA).

Mandane Bovei, ROSA, Ann. Mus. Civ. Genova, vol. vii (2a), 1887, p. 143.

Definition. *Length,* 35 *mm.; diameter,* 3 *mm.; number of segments,* 100. *Prostomium prolonged over two-thirds of buccal segment. Clitellum, XIII–XVI, rendered incomplete on last two segments by a triangular area of non-glandular epidermis. Setae in eight series, distance between which increases dorsally. Male pores correspond in position to second setae. Spermathecal pores are related to the same setae. Papillae, two pairs on X, XI, between ventral setae; a median papilla on IX. Penial setae ornamented with 'large obtuse tubercles.' Spermathecae in VIII, IX, each with two diverticula*[1]. *Hab.—Puntarenas, Straits of Magellan.*

[1] '*Nefridiopori* e *pori dorsali* non visti' (ROSA).

(19) **Acanthodrilus macleayi,** Fletcher.

A. Macleayi, Fletcher, Proc. Linn. Soc. N. S. W., iv (2), 1890, p. 999.

Definition. *Length,* 27 *mm.; diameter,* 2 *mm.; number of segments,* 90. *Prostomium prolonged over less than half the buccal segment. Clitellum, XII–XVI (XVII). Setae strictly paired. Papillae large, median swellings on XVI, XVII, and a few following segments. Male pores ventral of the position of the first setae. Penial setae flattened at free extremity, 'minutely notched distally.' Hab.—Napier Range, N. W. Australia.*

Fletcher is not quite clear as to the sperm-sacs, which, according to him, lie in x, xii. The alimentary canal has a gizzard. This is the smallest species of *Acanthodrilus.*

(20) **Acanthodrilus australis,** Michaelsen.

A. australis, Michaelsen, JB. Hamb. wiss. Anst., vi, 1889, p. 9.

Definition. *Length,* 140 *mm.; diameter,* 6 *mm.; number of segments,* 443. *Prostomium does not divide buccal segment. Clitellum, XIII–XIX. Setae strictly paired. Dorsal pores appear to commence XII/XIII. Papillae in pairs on intersegmental furrows, XI/XII, XII/XIII, XVIII/XIX, between ventral and lateral pairs of setae. Gizzard in segment VI. Nephridiopores in front of dorsal setae. Male and spermathecal pores in line with ventral pair of setae. Sperm-sacs in X, XI, XII. Spermathecae with minute diverticula concealed in the walls of the duct. Penial setae particularly long,* 2·4 *mm., not ornamented. Hab.—Cape York, Australia.*

(21) **Acanthodrilus schmardae,** Beddard.

A. Schmardae, Beddard, Ann. and Mag. Nat. Hist., Feb., 1892, p. 132.

Definition. *Length,* 60 *mm.; diameter,* 5 *mm. Clitellum, XII–XVII, incomplete. Dorsal pores present. After gizzard are five thickened septa. Anterior pair of spermiducal glands are much larger than those which follow. Penial setae with ornamentation. Spermathecae with an inconspicuous diverticulum; posterior pair the larger. Copulatory glands and setae in the neighbourhood of the spermathecae; one pair of these glands behind last pair of spermathecae and a sac of copulatory setae between them; a second pair behind these. Setae not ornamented. Hab.—Rockhampton, Queensland (fresh water).*

(22) Acanthodrilus annectens, Beddard.

A. annectens, Beddard, Q. J. M. S., vol. xxix, 1889, p. 102.

Definition. *Length, about 75 mm. Colour during life 'pink, or white and pink.' Prostomium not completely dividing buccal segment. Clitellum, XIII–XIX, saddle-shaped. Male pores in position of seta 2, which is absent, seta 1 being present. Sperm-duct-pores to the outside of ventral pair of setae. Gizzard in V; no calciferous glands. Intestine with well-developed typhlosole. Dorsal vessel double; last hearts in XIII. Nephridia open by outermost setae; the first pair is a 'peptonephridium.' Gonads attached to hinder wall of their segments. Sperm-ducts imbedded in body-wall. Spermathecae each with four diverticula, opening on to exterior in front of and to ventral side of third seta. No penial setae. Hab.—New Zealand.*

This species and the next form a very distinct pair of *Acanthodrilus*, as will be seen from a comparison of their characters with those of other species. I have not referred in the above definition to the genital papillae which are present in this as in so many other species of the genus. In one specimen there were a pair lying in line with the ventral pair of setae between segments ix/x; behind these there was a single median papilla on xv and another on xvi; in segments xix, xx were three papillae, two on one side of the middle line and one on the other. Another specimen had a papilla on each of segments xviii, xix.

(23) Acanthodrilus paludosus, Beddard.

A. paludosus, Beddard, P. Z. S., 1892, p. 677.

Definition. *Length, about 25 mm.; diameter, 1 mm. Clitellum, XIII–XIX. Setae distant; the outer setae only of ventral pair on XVII and XIX missing. Male pores correspond in position to missing seta of their segment. Sperm-duct pores to outside of ventral setae of XVIII. Papillae on XI, XII, and XVIII. Gizzard in V and VI chiefly in the latter segment; intestine begins in XX. First pair of nephridia modified to form a peptonephridium. Sperm-ducts run in the thickness of the body-wall, uniting just at external pore. Sperm-sacs in IX, XI, and XII. Spermathecae each with two small diverticula. Penial setae absent. Hab.—New Zealand (in a marsh).*

This species comes nearest to *A. annectens;* it differs from it principally in the

fact that the gonads are normal in position, i. e. attached to the front wall of their segments. I found no egg-sacs, but as the clitellum was not developed, the single specimen examined by sections was not fully mature.

(24) Acanthodrilus ungulatus, Perrier.

A. ungulatus, Perrier, Nouv. Arch. Mus., 1872, p. 85.

A. Layardi, Beddard, P. Z. S., 1886, p. 168.

Definition. *Length, 1–2 ft. Prostomium completely dividing the buccal lobe. Clitellum, XIII–XVII, complete except on last segment. Setae strictly paired, absent only on segments XVII, XIX ventrally where they are replaced by the penial setae. Dorsal pores commence between segments X/XI. Sperm-duct pore lies to outside of ventral pair of setae. Dorsal vessel single; last hearts in XIII. A gizzard present. Sperm-sacs in X, XI, XII. Spermathecae with a very indistinctly marked diverticulum. Copulatory glands and setae near to them. Penial setae ornamented with jagged cross ridges. Hab.—New Caledonia.*

I have no doubt that Horst (2) is correct in identifying my *A. layardi* with Perrier's *A. ungulatus*. The most marked peculiarity of the species is the presence of copulatory setae and glands in the neighbourhood of the spermathecae. In my description of the species I referred to the presence of a pair of pores upon the buccal segment on either side of the prostomium; this requires identification by means of sections; and therefore, until better preserved material is examined it is necessary to lay stress upon this supposed character of the species, which is at any rate unique among earthworms. The accessory copulatory structures found in the vicinity of the spermathecae are by no means always developed even in sexually mature individuals. I found them in various stages of development; and Horst did not find them at all in the specimens which he examined. The position of the ovary of this species (perfectly normal) which I failed to find was discovered by Horst.

(25) Acanthodrilus decipiens (new species).

Definition. *Length, 35 mm.; diameter, 2–3 mm.; number of segments, 110. Clitellum, XIII–XVII. Median genital papillae upon XVII, XIX, XX. Prostomium complete. Setae paired, but not strictly. Dorsal pores present. Gizzard large. Nephridia paired. Spermathecae with one diverticulum of good size. Spermiducal glands extend through three segments. Penial setae unornamented. Hab.—Estancilla, Valdivia.*

(26) Acanthodrilus occidentalis (NEW SPECIES).

Definition. *Length*, 192 *mm.; diameter*, 9 *mm.; number of segments*, 365. *Prostomium complete. Setae strictly paired, on ventral surface of body. Dorsal pores commence at segment XI or XII. Gizzard in VI; no calciferous glands; intestine begins in XVII. Last hearts in XIII. Nephridia paired. Testes in X, XI; sperm-sacs in XI, XII. Spermathecae with long tubular caecum. Spermiducal glands occupy one segment only; penial setae unornamented. Hab.—Valparaiso.*

This species has an appearance very like that of *Octochaetus multiporus*. During life it had a colour described by MICHAELSEN as 'blue-grey; head-end rose.'

(27) Acanthodrilus magellanicus (NEW SPECIES).

Definition. *Length*, 66 *mm.; diameter*, 3·5 *mm.; number of segments, about* 100. *Clitellum, XIII–XVII; genital papillae, a pair on XI, median elongate papillae upon XIV, XV. Setae not strictly paired, ventral nearer than lateral. Gizzard in VI. Septa VI/XII, stout. Last heart in XII. Nephridia paired. Testes in X, XI; sperm-sacs in XI, XII; spermathecae with two caeca, one above the other; spermiducal glands, confined to their segment, open separately from penial setae, which are ornamented with transverse ridges. Hab.—Magellan's Straits.*

This species might be mistaken on a first inspection for *A. bovei;* it has the same absence of integumental pigment.

(28) Acanthodrilus minutus (NEW SPECIES).

Definition. *Length*, 29 *mm.; diameter*, 3 *mm.; number of segments*, 70. *Clitellum, XIII–XVII. Prostomium complete. Setae strictly paired. Gizzard large; intestine begins in XVII. Testes in X; sperm-sacs in XI; spermathecae with tubular diverticulum; spermiducal glands confined to their own segment, the anterior pair larger. Penial setae not ornamented. Hab.—Putabla, Valdivia, S. America.*

This species again is one of those that appear to have no integumental pigment, which gives to it a superficial resemblance to *A. bovei*.

(29) Acanthodrilus bicinctus (NEW SPECIES).

Definition. *Length*, 42 *mm.; diameter*, 3 *mm.; number of segments*, 80. *Clitellum, XIII–XVI; median genital papillae on XX, XXI, XXII, XXIII. Prostomium incomplete. Setae*

strictly paired. Gizzard well developed. Testes in X; sperm-sacs in XI; spermathecae with a long diverticulum. Spermiducal glands occupying segments XVI–XX. Penial setae armed with spines. Hab.—Picton Island; Juan Island, S. America.

This species, closely allied to *A. dalei*, has the same plan of colouration as has that species.

(30) Acanthodrilus purpureus (NEW SPECIES).

Definition. *Length,* 95 *mm.; diameter,* 5 *mm.; number of segments,* 98. *Clitellum, XIII–XVI, complete. Prostomium does not extend over buccal segment. Setae strictly paired. Gizzard in VII. Last heart in XII. Spermathecae with tubular diverticulum dilated at end. Spermiducal glands extend through several segments. Penial setae with spinelets. Hab.—Magellan's Straits.*

This species is of the frequent dark-violet colour.

(31) Acanthodrilus chilensis (NEW SPECIES).

Definition. *Length,* 80 *mm.; diameter,* 5 *mm.; number of segments,* 150. *Clitellum, XIII–XVII. Prostomium complete. Setae strictly paired anteriorly, wider apart posteriorly, but the divergence is not so marked as in* A. platyurus. *Gizzard in VI, VII. Septa VIII/XII, stout. Last heart in XII. Testes in X; sperm-sacs in XI. Spermathecae with short diverticulum. Spermiducal glands not long. Penial setae of a brown colour in form like those of* A. platyurus. *Hab.—Teja Island, Valdivia.*

The colour (in alcohol) is dark purplish.

(32) Acanthodrilus cingulatus (NEW SPECIES).

Definition. *Length,* 58 *mm.; diameter,* 4 *mm.; number of segments,* 106. *Clitellum, XIV–XVIII. Prostomium complete. Setae strictly paired. Gizzard in VI, VII. Testes in X; spermathecae with small diverticulum. Spermiducal glands much coiled, anterior pair larger. Penial setae as in* A. platyurus. *Hab.—Teja Island, Valdivia.*

The colour in alcohol is rather brown than violet.

(33) Acanthodrilus putablensis (NEW SPECIES).

Definition. *Length,* 82 *mm.; diameter,* 8 *mm.; number of segments,* 150. *Clitellum, XIV–XVI. Prostomium complete. Setae strictly paired anteriorly, divergent posteriorly, and more so than in* A. platyurus. *Gizzard in VI. Septa VIII/XIV, stout. Last hearts in XIII. Testes in X; sperm-sacs in IX, XIII. Spermathecae with two short*

diverticula. Spermiducal glands confined to their segment, posterior pair smallest. Penial setae like those of A. platyurus. *Hab.—Putabla, Valdivia.*

(34) Acanthodrilus carneus (NEW SPECIES).

Definition. *Length,* 52 *mm.; diameter,* 3·5 *mm.; number of segments about* 100. *Clitellum, XIII–XVI, complete. Prostomium complete. Setae paired but not very strictly, ventral closer together. Genital papillae paired on IX, unpaired on X, XI. Dorsal pores begin in front of clitellum. Gizzard in VI. Last heart in XII. Testes in X; sperm-sacs in IX, XI; spermathecae with wavy tubular long diverticulum. Spermiducal gland with slender unornamented penial setae. Hab.—Quilipue, S. America.*

(35) Acanthodrilus plumbeus (NEW SPECIES).

Definition. *Length,* 28 *mm.; diameter,* 2 *mm.; number of segments,* 54. *Colour (in alcohol) a dull leaden blue. Prostomium complete* (?). *Setae closely paired ventrally, distant dorsally. Clitellum, XII–XIX, undeveloped between ventral setae. Dorsal vessel single up to segment XIV, in and after which it is double, the tubes uniting at septa; last heart in XIII. Nephridia alternate. Gizzard not strongly marked in VI. Calciferous glands in XIV, XV. Sperm-sacs in XI, XII. Spermathecae consisting of an oval sac sharply marked off from duct, which has thick muscular walls and is of about the same length and diameter. The latter bears a short globular sessile appendix which alone contains sperm. Spermiducal glands short, limited to their segments. Penial setae ornamented by transverse ridges, abruptly truncated at end, but, seen laterally, end in a point. Hab.—Mount Pirongea, Auckland, New Zealand.*

I owe this species to the kindness of Capt. Broun of Drury, N.Z.

Genus DIPLOCARDIA, GARMAN.

Syn. ? **Geodrilus,** UDE.

DEFINITION. **Setae paired, absent from segment XIX on which lie male pores; spermiducal gland pores on XVIII, XX; clitellum, XIII–XVIII. Gizzards two in V, VI. Nephridia paired. Dorsal vessel double. Spermiducal glands tubular in appearance, but with glandular cells into lobules opening often by separate ducts; penial setae small; spermathecae three pairs in VII–IX.**

The genus at present is only known by one species, unless indeed '*Geodrilus singularis*' of UDE be a different species. In any case it appears to me that the genus *Geodrilus* should not be separated from *Diplocardia.* It (*Geodrilus*) has,

according to UDE, two gizzards, paired nephridia and three pairs of spermathecae; but the male pores are stated to occupy the normal position for Acanthodrilidae, and nothing is said about the dorsal vessel.

Diplocardia communis, GARMAN.

D. communis, GARMAN, Bull. Illinois Lab., vol. iii, 1888, p. 47.
? Geodrilus singularis, UDE, Z. wiss. Zool., 1893, p. 69.

Definition. *Length, 300 mm.; number of segments, 165. Colour while living 'flesh-colour.' Prostomium not dividing buccal segment. Setae paired, absent only on XIX. Dorsal pores commence IX/X. Clitellum, XIII–XVIII, saddle-shaped on last two segments only; complete anteriorly. Nephridiopores in front of dorsal setae. Gizzards two in V, VI; intestine begins in XVII. Male pores on XVIII, XX. Dorsal vessel double from segment VII, the two halves uniting at the septa; last hearts in XII. Sperm-sacs in IX and XII; sperm-ducts in thickness of body-wall. Spermathecae three pairs in VII–IX, with a single diverticulum. Penial setae not ornamented. Hab.—Illinois, America.*

This species was originally described by GARMAN; I have been able to examine specimens and to confirm (adding to in a few quite minor points) his account. I distinctly observed in more than one case, the duct of the nephridium perforating the body-wall in front of the dorsal setae. The terminal part of the tube is not, as in most *Acanthodrilus*, a conspicuous muscular sac; it is, as in *A. annectens*, a narrow glandular tube and might thus readily escape observation. The ovaries seem to be unusually large; so, too, are the egg-sacs, which are not closely related to the oviducal funnel. The two spermiducal gland pores of each side of the body are, as is nearly, if not quite, universal in the genus, connected by a longitudinal furrow. This furrow has a curved course, the concavity being contrary to what is usually found outwards.

The spermiducal glands have, as is shown in GARMAN'S figures, a remarkable pitted appearance; white rounded masses are imbedded in a darker groundwork. They are not unlike a Mammalian ovary in aspect. They are wider at the end where they suddenly narrow into the duct, and extend through two or three segments. The curious appearance of the glands, unlike what is found in other *Acanthodrili*, is due to the massing of the gland cells in separate glands (as in *Perichaeta*), and to a corresponding development of branches of the duct (see p. 118).

The diverticulum of the spermathecae is attached to the long stalk of that organ. The diverticulum consists of three globular, more or less separate, sacs.

The penial setae are a pair to each orifice, but much closer together than the ordinary setae; they are also much more slender, but not very long; they are not to be seen with a lens when the worm is dissected.

There are two pairs of papillae, one in front of the anterior and one behind the posterior, pores, on the border line of segments xvii/xviii, xx/xxi respectively.

I believe *Geodrilus singularis* to be merely a variety of this species. It is much smaller (65 mm.), but otherwise agrees very closely.

Genus OCTOCHAETUS, BEDDARD.

Syn. **Acanthodrilus,** BEDDARD (in part.).

DEFINITION. **Setae eight per segment, distant; present on XVIII. Prostomium not dividing buccal segment. Male pores on very prominent papillae. Gizzard in V or VI, or V and VI. Calciferous glands as dilatations of oesophagus; one or two in XV, XVI or XVII, XVIII. Nephridia diffuse; a peptonephridium present. Dorsal vessel completely double.**

This genus contains but four species, which are all natives of New Zealand, and the above definition of it is somewhat shortened from the original definition given by myself (**57**, p. 668). On account of the characters of *O. antarcticus* the genus cannot be quite so clearly defined as it might otherwise be. This species and *O. multiporus* are the only ones which possess penial setae; but the penial setae are much less specialized in character than they are in other Acanthodrilidae. The three remaining species are very closely allied to each other; two of them indeed (*O. multiporus* and *O. thomasi*) are so near that they can practically be only distinguished by size. I believe, however, that a constant difference in size is a valid specific character, and I have allowed it in the case of the two species *Acanthodrilus dissimilis* and *A. parkeri*. *O. huttoni*, on the other hand, cannot possibly be confounded with any of the other species of its genus. The principal characters of the three species (leaving out *O. thomasi*, which hardly differs from *O. multiporus* except in size) are as follows:—

	CLITELLUM.	CALCIFEROUS GLANDS.	GIZZARD.	HEARTS.	GONADS.	FIRST DORSAL PORE.	PENIAL SETAE.
O. multiporus .	xiii–xx	xvii or xviii	vi or v/vi	x–xiii	attached to posterior walls of segments	?	present
O. antarcticus .	xii–xvii	xv, xvi	vi	,,	attached to front walls of segments	v/vi	,,
O. huttoni . .	xiii–xx	,,	v	x–xii	attached to front walls of segments	xi/xii	absent (?)

It will be observed from this table that *O. huttoni* agrees with *O. multiporus* in one (possibly two or three is the position of first dorsal pore and penial setae), with *O. antarcticus* in two characters also, while it differs from both in two characters, to which should be perhaps added a third, for the male pores are borne at the top of very unusually pronounced papillae. These papillae are more developed in those Acanthodrilidae which have no penial setae, but they seem to be most conspicuous in *O. huttoni*.

The genus is absolutely confined to New Zealand.

(1) Octochaetus multiporus, Beddard.

Acanthodrilus multiporus, Beddard, P. Z. S., 1885, p. 813.

O. multiporus, Beddard, P. Z. S., 1892, p. 674.

Definition. *Length, up to* 14½ *inches; breadth (at clitellum),* 13 *mm.; number of segments,* 238. *Colour during life, pink; clitellum, white. Clitellum, XIII–XX. Dorsal pores present. Gizzard in V and VI or VI alone. Calciferous glands (one pair) in XVII (or sometimes in XVIII); intestine begins in XIX, typhlosole commencing four or five segments further back, a very prominent fold, terminating some segments before the end of the body. Seven much thickened septa; round the middle of the gizzard is inserted a very delicate septum (V/VI); in front of this are two recognizable septa, the anterior of the two corresponding to the first septum of* A. huttoni, *but they do not approximate in position to the boundary-line between segments III/IV and IV/V. In posterior segments of the body the nephridia are particularly well developed and open into tubular diverticula of the gut. The dorsal vessel is double, commencing to be so in segment VI, and there are four pairs of dilated hearts in X–XIII. The testes are attached to hinder walls of their respective segments. The ovaries also are attached to the posterior wall of segment XIII, close to, and in contact with, the funnels of the oviduct. The spermathecae (in VIII, IX), with diverticula imbedded in the body-wall, exist. Penial setae present, though small. Hab.—Neighbourhood of Dunedin and of Ashburton, New Zealand.*

There are a number of sensory papillae on the anterior segments, a description of which is not included in the above, as they vary somewhat in number and arrangement. In one specimen there were seven pairs in front of the male pores, intersegmentally placed, commencing before viii/ix, and omitting xiii/xiv; the first pair were the smallest; there was another pair between xx/xxi; the three last pairs of the anterior series were fused to form single papillae. In another there was the same number of pairs, but the two last were distinctly paired; the two papillae of the very last

pair were further apart than those in front. Since my original description of this species (**8**), I worked out in greater detail its anatomical characters, and studied the embryology[1]. In one out of a number of young worms ready for hatching but still within the cocoon, I found the prostomium to be complete and the dorsal vessel to be single. In other respects this specimen agreed entirely with the present species.

(2) Octochaetus thomasi, Beddard.

O. Thomasi, Beddard, P. Z. S., 1892, p. 671.

Definition. *Length,* 144 *mm.; diameter,* 5 *mm.; number of segments,* 230[2]. *Clitellum, XIII–XIX. Dorsal pores not seen. Gizzard occupies segments V and VI; calciferous glands in XVII; intestine commences in XIX. First septum separates segments IV/V; septa VI/VII to XII/XIII thickened. Dorsal vessel becomes double in segment VII; four pairs of hearts in X–XIII. Gonads attached to posterior walls of segments. Spermathecae with numerous minute diverticula crowded round duct at pore. Hab.—New Zealand.*

(3) Octochaetus huttoni, Beddard.

O. Huttoni, Beddard, loc. cit., p. 674.

Definition. *Length,* 130 *mm.; breadth (at clitellum),* 7 *mm.; number of segments,* 233. *Colour during life, pink; clitellum white. Clitellum, XIII–XIX (XX). Setae in couples not closely approximated. Dorsal pores commence XI/XII. Gizzard in V. In segments XV, XVI, calciferous glands; intestine begins in XVIII, but typhlosole (which is very prominent) does not begin before XX, ending at about sixty segments before the end of the body. First septum is in front of proventriculus; it separates III/IV. After gizzard are six stout septa, and following these are two which are rather more developed than the rest, but not so strong as those which precede them. Dorsal vessel double. Three pairs of dilated hearts in X, XI, XII. All the gonads are attached to the front walls of their respective segments. Spermathecae (in VIII, IX) with a minute clump of diverticula presenting the appearance of a solid white body of about the size of a pin's head. Hab.—New Zealand.*

This species is clearly nearly allied to *A. multiporus.*

[1] See Beddard, No. 51.

[2] None of the specimens examined were quite intact; the above measurements are probably nearly right.

(4) Octochaetus antarcticus (BEDDARD).

Acanthodrilus antarcticus, BEDDARD, P. Z. S., 1889, p. 378.
O. antarcticus, BEDDARD, ibid., 1892, p. 669.

Definition. *Length, 240 mm.; breadth (at clitellum), 7 mm.; number of segments, 176. Clitellum, XII–XVII. Setae in couples, not closely approximated. The two setae of each ventral couple rather closer together than those of the dorsal couples. At the posterior end of the body the setae are longer and more prominent than anteriorly, being borne upon more distinctly marked papillae. Dorsal pores commence V/VI. Gizzard in VI; calciferous glands in XV, XVI*[1]*; in XVII the very narrow oesophagus suddenly widens out into the intestine. First septum in front of gizzard; like the one which immediately follows the gizzard it is thin and transparent. The six next septa (the last of which bounds the twelfth segment posteriorly) are thick and muscular. Dorsal vessel completely double; four pairs of dilated hearts in X–XIII. Gonads all attached to front wall of their segment. In addition to racemose sperm-sacs of other species this has two pairs of tongue-shaped sacs in IX and X. Penial setae present, with very faintly marked ornate ridges at tip. Spermathecae, two pairs (in VIII, IX) with three or four small diverticula clustered round the duct. Hab.—New Zealand.*

The penial setae are very small as compared, for example, with those of *Acanthodrilus dissimilis*, but they are more decidedly and for a longer tract ornamented than I have indicated in Q. J. M. S., vol. xxx, Pl. xxx, fig. 17.

Genus KERRIA, BEDDARD.

DEFINITION. Setae paired, present on all the segments of the body except seta 2 on segments XVII, XIX of some species. No dorsal pores. Nephridia paired. One pair of testes in X. Spermiducal glands lined by a single layer of cells; no penial setae. Spermathecae with or without diverticula.

This genus consists of four species. The first of these was described some three years since by ROSA (**6**), who regarded it merely as a species of the genus *Acanthodrilus*. It is evident, however, from his account of the structure of this '*Acanthodrilus*' that it shows characters not found in other specimens of the genus *Acanthodrilus* then known or since discovered. In the first place the spermathecae, although occupying

[1] In the fourteenth segment the oesophagus is swollen, and has very thick folded walls; perhaps this may be counted an anterior gland; the diameter is, however, considerably less than in the two next segments.

the segments which these organs always occupy in the genus *Acanthodrilus*, differ from those of other species in not possessing any diverticula; 'esse sono assolutamente prive di diverticoli, fatto che ho verificato anche colle sezioni, sapendo che il Beddard considera la presenza dei diverticoli nelle spermateche degli Acantodrili come costante,' says Dr. Rosa (**6**, p. 518). The second point in which this species differs from the genus with which it was associated by Rosa is in the position of the calciferous glands; these are present to the number of a single pair only. In other Acanthodrilidae there may be only a single pair of these organs; but where there is one pair only (as in *O. multiporus*) that pair is placed far back in the seventeenth or in the eighteenth segment. More characteristic of the family is the existence of three pairs; all the members of the genus *Benhamia* have three pairs.

More recently I have examined an Acanthodriloid worm which is not far distant from '*Acanthodrilus*' *spegazzinii* in structure. This species was referred by myself (**25**) to a separate genus on account of the four following characters (two of which were described by Rosa in his species):—

(1) Spermathecae without diverticula.
(2) Calciferous glands one pair in ix.
(3) Spermiducal glands tubular, lined by a single layer of cells.
(4) Setae of segments xvii–xix, unmodified.

The other characters of the genus given in the above diagnosis are not alone sufficient to distinguish it from other Acanthodrilidae, but taken collectively serve to strengthen the arguments for its separation. Since my paper was published Eisen has met with two other species (**4**), which he assigns to the same genus; the characters of these species necessitate but a slight revision of the generic characters. Both of them have spermathecae with diverticula. There is no doubt, however, in my mind that they are rightly assigned to this genus. In the following table the characters of the species are given:—

	K. HALOPHILA.	K. MACDONALDI.	K. ZONALIS.
Genital setae	not smaller	smaller	smaller
Outer setae of xvii, xix . .	present	absent	absent
Spermathecae	no diverticula	diverticula	diverticula
Spermiducal glands . . .	two pairs	two pairs	four pairs
Gizzard	present	absent	absent
Intestine begins	xiii	xii	xii

The above table is taken from that of EISEN; but I have left out one or two characters, which appear to me to be of less importance; I have not included *K. spegazzinii*, because in the first place its inclusion in the genus cannot be regarded as a matter of certainty, and in the second place, a good many of the characters used here to differentiate the species—in fact most of them—are not specially referred to by ROSA. The genus is aquatic.

(1) Kerria spegazzinii (ROSA).

Acanthodrilus spegazzinii, ROSA, Ann. Mus. Civ. Genova, vol. ix (2a), 1889, p. 516.

Definition. *Length, 50–60 mm.; breadth, 3 mm.; number of segments, 110–120. Colour a dirty yellow, the clitellum orange. Prostomium extending over one-half of the buccal segment. Clitellum, XIII–XIX, complete, excepting where the apertures of the spermiducal glands and of the sperm-ducts are. Sperm-duct pores on XVIII close to first seta; spermiducal gland pores related to the ventral pair of setae. Oviducal pores in front of the second seta. No gizzard; septa VIII/IX thickened. Spermiducal glands of great length, extending back as far as the thirty-fifth segment, there are epidermic glands surrounding the external pores of the spermiducal glands, and also in a corresponding position on segments XVI and XX. Hab.—Temperley, near Buenos Ayres.*

This species is chiefly to be distinguished on account of its extraordinary long spermiducal glands, which are unparalleled in the family Acanthodrilidae. It may also be distinguished from the following species by the glands upon the sixteenth to the twentieth segments. ROSA considers that this species is probably identical with KINBERG'S *Mandane stagnalis;* it is unnecessary to remark that KINBERG'S brief description of the species is by no means sufficient whereon to form an opinion; he speaks of 'ventral tubercles' on the twenty-first and twenty-third segments; this character is rather suggestive of a *Lumbricus.* The only reason—and that is not a very good one—for uniting the two species is that they are both aquatic in habit. *Mandane stagnalis* comes from Monte Video.

The description of '*Acanthodrilus*' *spegazzinii* is followed by a few notes upon another species, which is thought to be probably distinct from it though near to it; it is a transparent white in colour with a rose-white clitellum. Like the preceding species it is found in meadow puddles. Besides the difference of colour the clitellum is more extensive, reaching from segment twelve to segment twenty. The clitellum also is undeveloped upon the whole of the ventral surface between the ventral setae. Moreover, the two spermiducal gland pores are connected by a furrow on each side —a character which is not mentioned for *K. spegazzinii*, though it is mentioned by

EISEN in his species; this latter fact leads me to doubt the justice of placing this species near to *K. spegazzinii*, or even perhaps in the same genus; but until further details are forthcoming it is useless to speculate as to its position in the system.

(2) Kerria halophila, BEDDARD.

K. halophila, BEDDARD, P. Z. S., 1892, p. 355.

Definition. *Length, 25–50 mm.; breadth, 1 mm. Clitellum, XIV–XIX. Spermiducal gland-pores behind or in front of the ventral setae of segments XVII and XIX; the sperm-duct-pores are just to the outside of the same setae of segment XVIII. Gizzard in VII. Septa separating segments V/IX thickened. The nephridia of the posterior segments are invested by a thick peritoneal coating. Hab.—Upper reaches of Pilcomayo river, in very saline water.*

(3) Kerria macdonaldi, EISEN.

K. McDonaldi, EISEN, Proc. Calif. Acad. (2), iii, 1892, p. 294.

Definition. *Length, 'one inch by one line' in diameter. Clitellum, XIV–XX. Male pores just to outside of outer seta of ventral pair. First septum divides segments IV/V; next four are thickened. No gizzard; intestine begins in XII. Septal glands in V–VIII. Spermathecae in VIII, IX, with trifid diverticulum, opening by outer setae. Hab.—Near San Jose del Cabo, California.*

This species is dealt with in a very complete fashion by EISEN; his paper upon this and the following species being fully illustrated. Its principal difference from *K. halophila* is, in the fact, that there are two pairs of spermathecae with diverticula; of these, however, EISEN states that they are sometimes absent and occasionally reduced to a single lobe; he mentions, as a noteworthy point, that the sperm was always found in the pouch itself and not in the diverticula—a circumstance which does not fall in with what has been observed in other worms whose spermathecae possess diverticula. Close to the opening of the spermiducal pores are a bundle of delicate leaf-like processes of the integument. There are two pairs of sperm-sacs situated in segments x, xi; in one individual another in xii was to be seen. Though this species agrees with the last in the fact that it has only a single pair of funnels, one individual had two pairs. The nephridia appear to commence in segment iv; those anterior to segment ix are smaller; those of ix larger; those of the two following segments again small; the posterior glands are large and closely invested with large peritoneal cells. The setae of this species are figured and described as

possessing a few minute pit-like excavations at the anterior end. The vascular system, as in *Ocnerodrilus*, is characterized by the possession of two pairs of contractile hearts in x, xi.

(4) Kerria zonalis, Eisen.

K. zonalis, Eisen, loc. cit., p. 311.

Definition. *Outer setae of segments XVII, XIX wanting. Four pairs of spermiducal glands. One pair of spermathecae in IX with diverticula. Gizzard absent; intestine begins in XII. Hab.—Near San Jose del Cabo, California.*

Of this species, Eisen had only a single incomplete specimen; his data, therefore, are necessarily deficient. The most remarkable feature about the anatomy of the worm is, of course, the presence of a pair of spermiducal glands to each of the four pores on the two segments xvii, xix. It is a character which not only serves to distinguish the species from its congeners, but is unique in the Oligochaeta. Both in this species and in the last the genital setae are stated to be smaller than the normal setae of the body, but they show no other differences.

Genus Deinodrilus, Beddard.

Definition. Setae, 12 per segment. Clitellum, XIV–XVI, complete. Dorsal vessel double. Calciferous glands absent. Nephridia diffuse. No penial setae.

I formerly regarded this genus as a type of a family distinct from the Acanthodrilidae (**48**). I am now, however, inclined to agree with Benham (**1**), and to place it in the family Acanthodrilidae, of which it is clearly a perfectly well-marked genus. Apart from the characters given in the above definition of the genus *Deinodrilus* can be distinguished from any other genus of the Acanthodrilidae by the existence of a 'pericardium,' to which I have already referred (p. 28).

Deinodrilus benhami, Beddard.

D. Benhami, Beddard, Q. J. M. S., vol. xxix, 1889, p. 105.

Definition. *Length, about 125 mm. Prostomium not dividing buccal lobe. Clitellum, XIV–XVI, complete. Male pores connected by groove which passes to outside of ventral setae. Septa separating segments VIII/XIII thickened. Gizzard in VI, VII; intestine with a well-developed typhlosole. Last pair of hearts in XIII. Sperm-sacs in XI, XII. Spermathecae with three diverticula. Hab.—New Zealand.*

This species has been studied by myself only; it appears to be a rather rare species, as in numerous consignments of worms from New Zealand I have only come across two specimens.

Genus PLAGIOCHAETA, BENHAM.

DEFINITION. Setae, 50–54 per segment, arranged in couples. Nephridia paired; alternating in position. Penial setae present.

This genus is only known by a single species.

Plagiochaeta punctata, BENHAM.

P. punctata, BENHAM, Q. J. M. S., vol. xxxiii, 1893, p. 294.

Definition. *Length*, 30 *mm.; diameter*, 5 *mm.; number of segments*, 89. *Colour brown, with white spots transversely disposed. Prostomium completely dividing buccal segment. Clitellum, XIV–XVIII, complete. Setae:* 48 *in IV;* 44 *in III;* 30 *in II; behind,* 50–54. *Male pores bounded by a ridge on either side. No very thick septa; those of XIII/XVI slightly thicker than others. Gizzard rudimentary; calciferous glands in XIV; intestine begins in XVI, spiral. Nephridia with caecum longer in case of dorsal pairs, begin in II. Sperm-sacs in IX–XII. Spermathecae in VIII, IX, with a single diverticulum. Hab.—New Zealand.*

This species is copiously illustrated by BENHAM in his paper. The great breadth of the body, as compared with its length, is one of the marked external characters; so, too, is the very peculiar colouring. The clitellum is of less diameter than the parts of the body adjacent; this is a curious resemblance to many species of *Perichaeta*, and unique among the Acanthodrilidae.

Genus TRIGASTER, BENHAM.

DEFINITION. Setae strictly paired. Clitellum extensive, XIII–XL. Three gizzards in VII–IX; calciferous glands absent. Nephridia diffuse; a mucous gland present. Penial setae absent.

This genus only contains one species.

Trigaster lankesteri, Benham.

T. Lankesteri, Benham, Q. J. M. S., vol. xxvii, p. 94.

Definition. *Clitellum, XIII–XL; from segment XVII onward there is a ventral area free from glandular modification. Prostomium not imbedded in the buccal segment. Setae strictly paired. No dorsal pores. Intestine begins in XIII. Spermathecae without any apparent diverticula. Hab.—St. Thomas, West Indies.*

Genus BENHAMIA, Michaelsen.

Syn. **Acanthodrilus,** Auct. (in part.).

Definition. Setae strictly paired, absent on segment XVIII ventrally. Clitellum incomplete. Two gizzards present; calciferous glands three pairs, very distinctly marked off from oesophagus. Nephridia diffuse. Two pairs of spermathecae. Penial setae nearly always present.

This genus contains a very considerable number of species, almost exactly the same number as of *Acanthodrilus*, viz. thirty-one. The genus has its head-quarters in tropical Africa, twenty-five of the species being there met with. One species certainly, and another more doubtfully, are found in the New World; three come from Java and Sumatra[1], while the single remaining species of the genus (*B. bolavi*) appears to be almost world-wide in its distribution. In addition to the species described in the present paper, I have examined a form from Trinidad, which seems to be different from any of them; it is remarkable on account of its bright green colour; unfortunately, an accident in the process of preservation prevents me from being able to do more than assign it to the present genus.

Under the description of the genus *Acanthodrilus* (see p. 528) I have referred to some of the structural differences between the two genera. The characters of the calciferous glands seem to distinguish this genus from all the remaining genera of the family excepting only *Plagiochaeta*. So, at any rate, it appears from such data as are to hand. The calciferous glands in those species which I have myself examined are reniform pouches, pinched off from the oesophagus, and marked by transverse furrows, along which run blood-vessels; Horst figures exactly the same

[1] Michaelsen is of opinion that those found out of Africa are accidental importations.

thing in *B. beddardi;* I am inclined to think that it will prove universal. *Plagiochaeta* seems to be the only other Acanthodrilid (see BENHAM, **19**) with calciferous

	LENGTH.	NUMBER OF SEGMENTS.	CLITELLUM.	FIRST DORSAL PORE.	PENIAL SETAE.	LOCALITY.
B. scioana . . .	70 mm.	100	xiii–xix	v/vi	smooth	Abyssinia
B. intermedia . .	46 mm.	128	xiii–xix (?)	,,	,,	West Africa
B. buttneri . . .	70 mm.	175	xii–xxi	xi/xii	with a few	Togo
B. pallida . . .	25 mm.	?			smooth and ornamented	,,
B. gracilis . . .	60 mm.	145	xiii–xx	v/vi (?)	,,	,,
B. togoensis . . .	,,	140			ornamented	,,
B. bolavi	,,	97	,,	v/vi	smooth and ornamented	Venezuela, Mexico
B. inermis . . .	,,	350	,,	xii–xiii	absent	Togo
B. rosea	540 mm.	400	xiii–xxii	xi/xii	smooth	Gaboon
B. stuhlmanni . .	140 mm.	187	xiii–xx	v/vi	ornamented	Quilimane
B. tenuis . . .	75 mm.	262	xiv–xix (?)		,,	Cameroons
B. schlegelii . . .	350 mm.	327		xiii–xiv	,,	Liberia
B. itiolensis . . .	380 mm.	214	xiv–xxii	v/vi	smooth	Victoria Nyanza
B. buttikoferi . .	320 mm.				ornamented	Liberia
B. affinis . . .	32 mm.	140	xiii–xxii	absent (?)	present (?)	Quilimane
B. beddardi . .	160 mm.		xiii–xx		ornamented	Liberia
B. godeffroyi . .	90 mm.	174	xiii–xix		,,	Hayti (?)
B. mexicana .	30 mm.	120	xiii–xxi	iii/iv	smooth	Mèxico
B. annae . .	,,	85	,,	iv/v	ornamented	Java
B. floresiana . .	40 mm.	125	,,	vi/vii	,,	Sumatra
B. malayana . .	30 mm.	95	xiii–xx	v/vi	smooth and ornamented	,,
B. crassa . . .	,,		xiii–xxi	,,	ornamented	Lagos
B. whytei . . .	75 mm.		xiii–xix	iii/iv	,,	Nyassa
B. monticola . .	42 mm.	109		v/vi	,,	Runssoro, E. Africa
B. sylvestris .	35 mm.	81	,,	iii/iv	,,	,,
B. castanea . . .	40 mm.	63	xii–xx	v/vi	,,	,,
B. parva . . .	32 mm.		,,	,,	,,	Bataibo, E. Africa
B. culminis . . .	37 mm.	95	xiii–xxi		two kinds, smooth	Runssoro, E. Africa
B. equatorialis . .	25 mm.	85	xii–xix		ornamented	,,
B. curta	16 mm.	52	xii–xviii	,,	,,	,,
B. kafuruensis . .	45 mm.	126	xiii–xx (?)	,,	smooth	Kafuru, E. Africa

pouches of this kind. MICHAELSEN has remarked that, frequently, calcareous concretions are only found in the first pair.

Another possibly diagnostic character of the genus (as contrasted, of course, with other Acanthodrilids) is apparent in the figures of MICHAELSEN. The spermatheca is divided by a sharp constriction, below which arises the single diverticulum (when there is only one). The shape is very characteristic. In two species MICHAELSEN (16) has described structures which look like spermaphores protruding from or lying within the pouches. Possibly, too, the development of muscular fibres round the end of the sperm-duct is a character of importance in distinguishing *Benhamia*. I have found it in *B. crassa* and *B. bolavi*. Unfortunately, too few species of the genus have been investigated histologically to allow of putting this forward as more than a suggestion; it is a point of resemblance to the genus *Microdrilus* and to *Ocnerodrilus* among the Cryptodrilidae (see p. 511). So, too, is the dorsal diverticulum of the buccal cavity (see p. 458), which is, perhaps, so far as this family is concerned, distinctive of the genus *Benhamia*. The other generic characters are embodied in the above diagnosis, and have been, to some extent, already discussed (see p. 525).

The species of this genus are not by any means easy to distinguish; they differ in very small characters. And, in addition to this, the difficulties are increased by the fact that a good many of them are but imperfectly known. The genus itself, on the other hand, seems to be capable of being very easily defined; this, indeed, is the difficulty when we come to the species; all the characters which vary much in other Acanthodrilids are fixed as generic characters. Some of the very smallest Acanthodrilidae belong to this genus, and, on the other hand, two of the largest of earthworms, *B. rosea*, and *B. itoliensis*.

The table on the preceding page will enable the species to be roughly grouped; it embodies the principal differences which exist between the species, not taking into consideration those which characterize only a single species, such as, for example, the accessory copulatory organs of *B. beddardi*.

The above thirty-one species are all that are at present known as belonging to the genus; but it is not certain that they are all 'good' species.

The Table will enable the species to be roughly sorted for purposes of identification into the following groups:—

Small sized species, with anteriorly placed first dorsal pore and with ornamented penial setae.

B. annae.	B. sylvestris.
B. floresiana.	B. castanea.
B. crassa.	B. curta.
B. whytei.	B. parva.
B. monticola.	

Small-sized species with anteriorly placed first dorsal pore and with smooth (unornamented) setae.

B. scioana. **B. mexicana.**

B. intermedia. **B. karafuruensis.**

Small-sized species with anteriorly placed first dorsal pore and with penial setae both smooth and ornamented.

B. gracilis. **B. bolavi.**

B. malayana.

Small-sized species (position of dorsal pore unknown) with smooth and ornamented penial setae.

B. pallida. **B. culminis.**

Small-sized species (position of first dorsal pore unknown) with ornamented penial setae.

B. togoensis. **B. equatorialis.**

B. godeffroyi.

Moderate sized species.

B. stuhlmanni. **B. beddardi.**

Large species with smooth penial setae.

B. itoliensis. **B. rosea.**

Large species with ornamented penial setae.

B. schlegelii. **B. buttikoferi.**

Species without penial setae.

B. inermis.

Small species with posteriorly placed first dorsal pore.

B. buttneri. **B. tenuis.**

Species in which the above characters are unknown.

B. affinis.

(1) Benhamia schlegelii, Horst.

Acanthodrilus Schlegelii, Horst, Notes Leyd. Mus., vi, 1884, p. 103.

Definition. *Length,* 350 *mm.; number of segments,* 327. *Spermiducal gland pores placed within an oval circumscribed area as in* B. rosea. *Prostomium continued by grooves on to buccal segment. Setae paired. Dorsal pores commence XIII/XIV or XIV/XV. Gizzard single* (?)*; three pairs of calciferous glands in XV, XVI, XVII. Dorsal vessel*

single; five hearts in X–XIII. Two pairs of sperm-sacs in XI, XII. Penial setae with numerous transverse rings of minute points. Spermathecae without recognizable diverticula. Hab.—Liberia.

This species undoubtedly comes very near to *B. rosea;* indeed, I am almost inclined to believe that a careful comparison would show them to be the same species. The only difference appears to be the ornamentation of the penial setae in the present worm, and the absence of any ornamentation in *B. rosea;* the first dorsal pore, however, is further forward in *B. rosea;* and for the present I keep the two forms apart though without any strong conviction that this course is the right one. It also comes near to *B. buttikoferi.* It has formed the subject of two contributions by HORST (**1, 2**).

(2) Benhamia buttikoferi (HORST).

Acanthodrilus Büttikoferi, HORST, Notes Leyd. Mus., ix, 1887, p. 291.

Definition. *Length, 320 mm. Clitellum, XIII (XIV)–XIX, with median ventral area, uninvaded by the modified epidermis, upon XVI–XIX. Setae paired; the two pairs of one side closer together anteriorly than in the posterior segments, as is also the case with* B. beddardi. *Prostomium continued by grooves on to buccal segment. Dorsal pores visible behind the clitellum. Two gizzards present lying in V and VII; three pairs of calciferous glands in XIV, XV, XVI. Septa separating segments VI/XII specially thickened. Mucous glands apparently present. Dorsal vessel single; four pairs of hearts in X–XIII. A single pair of sperm-sacs in XII. Penial setae swollen at free extremity, and ornamented with a series of spinelets, the apices of which are directed forwards. Spermathecae without apparent diverticula. Hab.—Liberia.*

In addition to the above reference, see HORST (**4**).

(3) Benhamia beddardi (HORST).

Acanthodrilus Beddardi, HORST, Notes Leyd. Mus., x, 1888, p 123.

Definition. *Length, 160 mm. Clitellum, (XIII) XIV–XIX (XX), saddle-shaped. Prostomium rather long. Setae strictly paired. Two gizzards and three pairs of calciferous glands in XIV, XV, XVI(I). Mucous glands present. Dorsal vessel single, four pairs of hearts. Penial setae ornamented at extremity with numerous spinelets, the apices of which are directed towards the free end of the setae. Spermathecae with several minute diverticula 'only obvious in transverse sections.' In the neighbourhood of the spermathecae are two bundles of copulatory setae accompanied by glands. Hab.—Liberia.*

This is a species about whose distinctness there can be no doubt; it may be distinguished from any other *Benhamia* by the 'copulatory apparatus' in the vicinity of the spermathecae; an apparatus of this kind is found in a few species of *Acanthodrilus*.

(4) Benhamia scioana (Rosa).

Acanthodrilus scioanus, Rosa, Ann. Mus. Civ. Genova, vol. vi (2 a), 1886, p. 586.

Definition. *Length,* 70 *mm.; breadth,* 3 *mm.; number of segments,* 100. *Clitellum, XIII–XIX, with a median ventral area upon XVII–XIX. Setae strictly paired. Dorsal pores commence V/VI. Gizzards in V, VI; calciferous glands in XV, XVI, XVII; intestine begins in XIX and is without a typhlosole. Dorsal vessel single* (?)*; hearts of XI and XII are the largest. Penial setae present and without sculpturing. Sperm-sacs, two pairs in XI, XII; these are connected, as in* B. beddardi, *with a median space occupying segments X, XI. Egg-sacs present, but rudimentary. Spermathecae with a single small diverticulum. Hab.—Shoa, Abyssinia.*

Apart from a slight difference in size I do not see how to differentiate this species from *B. intermedia;* that they are different is probable from their occurrence on opposite sides of the African continent.

(5) Benhamia rosea, Michaelsen.

B. rosea, Michaelsen, JB. Hamb. wiss., Anst. vi, 1889, p. 6.

Definition. *Length,* 540 *mm.; breadth,* $10\frac{1}{2}$ *mm.; number of segments,* 400. *Reddish pigment in skin. Clitellum, XIII–XXII, saddle-shaped. Spermiducal gland pores enclosed by a ridge of oval contour, extending from the middle of segment XVI to the end of segment XIX. Prostomium broad and large, but not continued on to buccal segment. Setae very small and strictly paired. Dorsal pores begin between XI/XII. Gizzards in VII, VIII, and IX* (?). *Penial setae without ornamentation. Spermathecae with numerous minute diverticula imbedded in muscular wall. Hab.—Gaboon and Leibange, West Africa.*

The close approximation of the male pores appears to distinguish this species from its allies except *B. schlegelii* (q. v.); it is moreover the largest member of its genus.

(6) Benhamia stuhlmanni, Michaelsen.

B. Stuhlmanni, Michaelsen, loc. cit., vii, 1890, p. 5.

Definition. *Length,* 140 *mm.; breadth,* 6 *mm.; number of segments,* 187. *Clitellum,*

XIII–XX. Spermiducal gland pores lying upon a sucker-like hour-glass-shaped ventral area. Prostomium, triangular in form, imbedded in first segment. Setae strictly paired. Dorsal pores begin V/VI. Gizzards in VIII and IX; calciferous glands in XIV, XV, XVI; intestine with typhlosole. Septa, X/XI–XIII/XIV are specially thickened. Sperm-sacs in XI and XII; free masses of developing sperm also found in X, XI, XII. Penial setae with fine denticulate ridges on extremity. Spermathecae with a single diverticulum. Hab.—Quilimane, East Africa.

This species comes nearest to *B. whytei*, but it is larger and the penial setae are different in shape.

(7) Benhamia tenuis, MICHAELSEN.

B. tenuis, MICHAELSEN, loc. cit., viii, 1891, p. 21.

Definition. *Length*, 75 *mm.; breadth*, $3\frac{1}{2}$ *mm.; number of segments*, 262. *Clitellum, XIV–XIX* (?). *Prostomium small, not continued by grooves on to buccal segment. Setae strictly paired. Dorsal pores present; begin about XIII/XIV. Calciferous glands in XIV, XV, XVI* (?). *Penial setae with extremity denticulate. Spermathecae with a single diverticulum. Hab.—Barombi, Cameroons, West Africa.*

This species is only briefly described by Dr. MICHAELSEN, and it is not certain whether it be really different from *B. crassa.*

(8) Benhamia intermedia, MICHAELSEN.

B. intermedia, MICHAELSEN, Arch. f. Nat., 1891, p. 225.

Definition. *Length*, 46 *mm.; breadth*, 3–4 *mm.; number of segments*, 128. *Skin pigmented dorsally. Clitellum, XIII–XIX* (?). *Prostomium continued by grooves about half-way along the buccal segment. Setae strictly paired. Dorsal pores commence V/VI. Gizzards in V and VI* (?). *Penial setae with very fine and irregularly bent extremity, not ornamented. Spermathecae with a small narrow diverticulum. Hab.—Togo, Bismarcks-burg, Adeli.*

(9) Benhamia bolavi, MICHAELSEN.

B. Bolavi, MICHAELSEN, JB. Hamb. wiss., Anst. viii, 1891, p. 9.

Definition. *Length*, 60 *mm.; breadth*, $1\frac{1}{3}$ *mm. during life. After preservation*, 40 *mm. by* $1\frac{1}{2}$ *mm. Number of segments*, 97. *Colour (during life), a dirty flesh-colour; clitellum yellowish or pale pink. Clitellum, XIII–XIX. Oviducal pore single and median upon XIV. Prostomium without prolongation by grooves on to buccal segment. Setae strictly paired; those of posterior segments larger. Dorsal pores commence V/VI. Gizzards*

in VII. Calciferous glands in XV, XVI, XVII, first pair the smallest, last pair largest. Intestine commences in XIX, but the typhlosole does not begin before XXI; it attains its full size in XXIII; from the twenty-eighth segment onwards there are two lateral typhlosolar folds in addition to the median fold. The pharynx is enveloped in a sac which is possibly the first dissepiment; otherwise that dividing VII/VIII is the first; none of the septa are greatly thickened. Mucous gland present. In X, XI, XII are dilated hearts. One pair of sperm-sacs in XI. Spermathecae with a single small diverticulum. Penial setae two to each sac and of a different form; the longer with about eight denticulations on the free extremity; the shorter is swollen at the extremity and has no denticulations. Hab.—Venezuela, Mexico (UDE).

(10) Benhamia mexicana, ROSA.

B. mexicana, ROSA, Ann. k. Hofm. Wien, Bd. vi, 1891, p. 394.

Definition. *Length,* 30 *mm.; breadth,* 2 *mm.; number of segments,* 120. *No pigment in skin. Clitellum, XIII–XXI, less developed ventrally, but there is no definite median area. Prostomium completely divides buccal segment* (?). *Setae paired, those of dorsal pair a little further apart than ventral. Dorsal pores commence III/IV. Gizzards in VIII and IX; calciferous glands in XV, XVI, XVII. Penial setae small, and without ornamentation. Spermathecae with a single small diverticulum. Hab.—Durango, Mexico.*

If it be really true that the prostomium is continued on to the buccal segment by grooves which divide the latter completely, there is no doubt about the very marked difference of this from other species.

(11) Benhamia godeffroyi, MICHAELSEN.

B. Godeffroyi, MICHAELSEN, JB. Hamb. wiss. Anst. vii, 1890, p. 55.

Definition. *Length,* 90 *mm.; breadth,* 4 *mm.; number of segments,* 174. *Anterior part of body apparently pigmented. Clitellum saddle-shaped,* (*XIII*) *XIV–XIX. Prostomium prolonged about half way over buccal segment. Setae strictly paired. Spermiducal glands of XVII more developed than those of XIX; penial setae slender, the extremity ornamented 'with numerous irregular unequally formed notches, which produce a knotty appearance.' Spermathecae without free diverticula, but apparently with rudimentary diverticula attached to the stalk of the pouch. Posterior pair more strongly developed than anterior pair. Hab.—Hayti* (?).

There is some doubt as to the habitat of this species. According to the labelling of the specimens when received at the Hamburg Museum from the Godeffroy Collection,

they might be natives of either Hayti or New Zealand. But Dr. MICHAELSEN points out that no true *Benhamia* has, as yet, been found in New Zealand, whereas in the Neotropical Region we have *Trigaster lankesteri* and the more recently described *B. mexicana.*

(12) Benhamia itoliensis, MICHAELSEN.

B. itoliensis, MICHAELSEN, loc. cit., ix, 2, 1892, p. 3.

Definition. *Length,* 380 *mm.; breadth,* 13 *mm.; number of segments,* 214. *Clitellum, XIV–XXII. Setae strictly paired. Dorsal pores commence V/VI. Calciferous glands in XV, XVI, XVII. Last heart in XII. Typhlosole consisting of three or five folds. Penial setae of a peculiar form, broad at insertion, and suddenly narrowed at free extremity, without sculpturing. Spermathecae with numerous diverticula imbedded in its walls. Hab.—Itoli, S. W. Victoria Nyanza.*

For this species see also MICHAELSEN (**16**).

(13) Benhamia affinis, MICHAELSEN.

B. affinis, MICHAELSEN, loc. cit., vii, 1890, p. 9.

Definition. *Length,* 32 *mm.; breadth,* 1 *mm.; number of segments,* 140. *No pigment in the skin. Clitellum, XIV–XXI (XIII and XXII slightly invaded by glandular tissue). Prostomium with a prolongation on to buccal segment. Setae strictly paired. Dorsal pores absent* (?). *Penial setae present* (?). *Spermathecae as in* B. stuhlmanni. *Genital papillae upon the border-lines of segments VIII/IX, IX/X. Hab.—Quilimane, East Africa.*

This species is one of the smallest of earthworms; it is chiefly to be distinguished from *B. stuhlmanni* by its size and by the existence of the median papillae upon the intersegmental furrows viii/ix, ix/x. I am not quite clear from MICHAELSEN's account whether penial setae are present or not; I assume, however, as nothing is definitely said to the contrary, that they are present.

(14) Benhamia buttneri, MICHAELSEN.

B. Büttneri, MICHAELSEN, Arch. f. Nat., 1892, p. 259.

Definition. *Length,* 70 *mm.; breadth,* $4\frac{1}{2}$ *mm.; number of segments,* 175. *Prostomium sends back a triangular process to nearly middle of buccal segment. Clitellum, XII–XXI, saddle-shaped. Dorsal pores commence XI/XII. Spermathecae with a minute wart-like*

diverticulum. Penial setae not attenuated at extremity, where there are a few denticulations generally bifid. Hab.—Togo.

This species again is very like the three that have been just described; the only difference that can be gathered from MICHAELSEN'S description is in the form of the penial setae and in the fact that there is only one kind of them.

(15) Benhamia togoensis, MICHAELSEN.

B. togoensis, MICHAELSEN, loc. cit., p. 260.

Definition. *Length, 60 mm.; breadth, 2½ mm.; number of segments, 140. The setae anteriorly more strictly paired than posteriorly, and smaller. Their form is, so far as we know at present, unique among the Acanthodrilidae in that they are ornamented with numerous fine denticles. The penial setae are ornamented after the same fashion as the ordinary setae. Hab.—Togo.*

This species is easily distinguishable by the presence of ornamented setae upon the segments of the body. There is no other species of *Benhamia* in which this ornamentation of the setae has been met with.

(16) Benhamia inermis, MICHAELSEN.

B. inermis, MICHAELSEN, loc. cit., p. 209.

Definition. *Length, 600 mm.; breadth, 10 mm.; number of segments, 350. Clitellum, XIII–XX, saddle-shaped. Male pores upon a circumscribed area, the pores of segment XIX somewhat nearer together than those of segment XVII. Genital papillae, eight pairs in front of the clitellum on the grooves between segments IX–XVI in front of the ventral setae; one pair upon segment VIII just to the outside of the spermathecal pore; behind the clitellum two papillae on the left side between segments XX/XXII, and one pair between XIX/XX; on the clitellum three pairs, one between XVI/XVII; the next to the outside of these on XVII, followed by a pair on XVIII corresponding in position to the last. Dorsal pores commence XII/XIII. Gizzards in V, VI; calciferous glands in XI, XII, XIII. Spermathecae have (apparently) no diverticula. Penial setae completely absent. Hab.—Togo.*

This species is nearly unique among its genus for the absence of penial setae; the only other species in which these setae, so characteristic for the genus *Benhamia*, are absent, is *Trigaster lankesteri*. *B. inermis* is the largest of Acanthodrilids.

(17) Benhamia pallida, Michaelsen.

B. pallida, Michaelsen, loc. cit., p. 258.

Definition. *Length,* 25 *mm. Spermiducal gland slender; penial setae present and of two kinds; the larger are furnished at extremity with a few denticles which are occasionally bifid; the other setae are smooth. Hab.—Togo, Bismarcksburg, West Africa.*

This species can hardly be distinguished from *B. bolavi;* the only difference appears to be in the presence upon the free end of the penial setae of one particularly large denticulation, illustrated by Michaelsen in a woodcut (fig. B, p. 259).

(18) Benhamia gracilis, Michaelsen.

B. gracilis, Michaelsen, loc. cit., p. 258.

Definition. *Length,* 60 *mm.; breadth,* 3 *mm.; number of segments,* 145. *Clitellum saddle-shaped, XIII–XX. Oviducal pore single and median just behind intersegmental furrow, XIII/XIV. Dorsal pores commence V/VI (?). Six median papillae on furrows IX/X–XIII/XIV and XXIII/XXIV. Penial setae of two kinds; one, the larger, with a few broad bifid denticulations at the extremity; the other, the smaller, with very few simple denticulations. Hab.—Togo.*

(19) Benhamia malayana, Horst.

B. malayana, Horst, Zool. Ergebn. Ost-Indien, ii, p. 35.

Definition. *Length,* 20–30 *mm.; number of segments,* 95. *Skin without any pigmentation. Clitellum, XIII–XX, complete. Prostomium continued on to buccal segment. First dorsal pore between segments V/VI or VI/VII. Spermathecae with a single diverticulum. Penial setae of two kinds; the longer terminate in four spinelets, the shorter has a spoon-like extremity. Hab.—Flores; Sumatra; Celebes.*

Horst correctly remarks that this species shows considerable resemblances to *B. bolavi;* it differs, however, in its stouter build, its complete clitellum, and in having two instead of only one oviducal pore. The latter character also distinguishes the present species from *B. gracilis. B. pallida* is another species which comes very near to the present; the smooth setae of that form, however, are not stated to have a spoon-like swollen extremity.

(20) Benhamia annae, Horst.

B. Annae, Horst, loc. cit., p. 32.

Definition. *Length, 30 mm.; number of segments, 85. Skin without pigment. Clitellum, XIII (XIV)–XXI, complete. Prostomium imbedded in buccal segment. Dorsal pores commence IV/V. Spermathecae with a single diverticulum. Sperm-sacs in segments IX–XII. Penial setae undulated with slight denticulations. Hab.—Java.*

This species is very like the former, but appears to differ in the possession of a complete clitellum; *B. crassa* has median unpaired papillae upon segments viii/ix, ix/x not mentioned in this form. *B. godeffroyi* has not the distinct diverticulum of the spermatheca, which the present species has.

(21) Benhamia floresiana, Horst.

B. floresiana, Horst, loc. cit., p. 34.

Definition. *Length, 35–40 mm.; number of segments, 125. Skin without any pigmentation. Clitellum, XIII–XXI, incomplete. Prostomium as in last species. Dorsal pores commence VI/VII. Spermathecae with a single diverticulum. Penial setae as in the last species. Hab.—Flores, Sumatra.*

(22) Benhamia crassa, Beddard.

B. crassa, Beddard, P. Z. S., 1892, p. 681.

Definition. *Length, 25 mm. (about). Clitellum, XIII–XXI, incomplete, except first two segments. Prostomium imbedded in buccal segment. Dorsal pores commence V/VI. Genital papilla on each of segments VIII/IX, IX/X. Spermathecae with a single diverticulum. Penial setae spiral with a few denticulations. Hab.—Lagos.*

(23) Benhamia whytei, Beddard.

B. Whytei, Beddard, loc. cit., p. 680.

Definition. *Length, 75 mm. Colour (in alcohol) dark brown. Clitellum, XIII–XIX, complete. Prostomium imbedded in buccal segment. First dorsal pore between III/IV. Last pair of hearts in XII. Six septa following gizzards are thickened. Spermathecae with a single diverticulum. Penial setae as in* B. crassa. *Hab.—Nyassa Land.*

This species is chiefly to be distinguished from those to which it comes nearest

by its greater size; the dorsal pores, too, appear to commence earlier than in any other species, with the exception of *B. mexicana,* with which the present cannot be confounded, and *B. sylvestris* which it closely resembles.

(24) Benhamia monticola, MICHAELSEN.

B. monticola, MICHAELSEN, Thierwelt Ost-Afrik. Regenw., 1894, p. 27.

Definition. *Length,* 42 *mm.; breadth,* 4 *mm.; number of segments,* 109. *Prostomium reaches to middle of buccal segment. Setae strictly paired. Dorsal pores commence V/VI. Penial setae with fine denticulations. Spermathecae with a single diverticulum. Hab.—Runssoro, E. Africa.*

(25) Benhamia sylvestris, MICHAELSEN.

B. sylvestris, MICHAELSEN, loc. cit., p. 28.

Definition. *Length,* 35 *mm.; breadth,* 3·5 *mm.; number of segments,* 81. *Skin pigmented dorsally. Clitellum, VIII–XX. Prostomium continued over half of buccal segment. Setae strictly paired. Dorsal pores commence III/IV. Gizzards in VIII and IX. Calciferous glands in XV, XVI, and XVII. Last heart in XII. Sperm-sacs in X, XI, with process into XII. Penial setae with fine denticulations. Spermathecae with small diverticulum. Hab.—Runssoro, E. Africa.*

(26) Benhamia castanea, MICHAELSEN.

B. castanea, MICHAELSEN, loc. cit., p. 301.

Definition. *Length,* 40 *mm.; breadth,* 3·5 *mm.; number of segments,* 63. *Pigment on dorsal surface. Clitellum, XII–XX. Prostomium projects slightly into buccal segment. Setae strictly paired. Dorsal pores commence V/VI. Calciferous glands in XV, XVI, XVII. Penial setae denticulate. Spermathecae with one diverticulum. Hab.—Runssoro, E. Africa.*

(27) Benhamia parva, MICHAELSEN.

B. parva, MICHAELSEN, loc. cit., p. 31.

Definition. *Length,* 32 *mm.; breadth,* 2 *mm. Dorsal surface pigmented. Setae strictly paired. Dorsal pores commence V/VI. Clitellum, XII–XX. Oviducal pore median. Calciferous glands in XV, XVI, XVII. Penial setae ornamented with ridges. Spermathecae with single diverticulum, bifid at extremity. Hab.—Duki, near Bataite, E. Africa.*

(28) Benhamia culminis, MICHAELSEN.

B. culminis, MICHAELSEN, loc. cit., p. 32.

Definition. *Length,* 37 *mm.; breadth,* 4 *mm.; number of segments,* 95. *Dorsally pigmented. Clitellum, XIII–XXI. Setae strictly paired. Penial setae of two kinds, one ending bluntly, the other in a fine point, both smooth. Spermathecae with a single small diverticulum. Hab.—Runssoro, E. Africa.*

(29) Benhamia equatorialis, MICHAELSEN.

B. equatorialis, MICHAELSEN, loc. cit., p. 32.

Definition. *Length,* 25 *mm.; breadth,* 2·5 *mm.; number of segments,* 85. *Dorsally pigmented. Clitellum, XII–XIX. Prostomium extends a little way into buccal segment. Setae strictly paired. Generative area on segments XVII–XIX, hour-glass shaped. Gizzards in VIII, IX. Calciferous glands in XV, XVI, XVII. Last hearts in XII. Sperm-sacs in X, XI, XII. Penial setae denticulate. Spermathecae with small diverticulum. Hab.—Runssoro, E. Africa.*

(30) Benhamia curta, MICHAELSEN.

B. curta, MICHAELSEN, loc. cit., p. 33.

Definition. *Length,* 16 *mm.; breadth,* 2·5 *mm.; number of segments,* 52. *Dorsally pigmented. Clitellum, XII–XVIII. Prostomium with short process into buccal segment. Setae strictly paired. Dorsal pores begin V/VI. Gizzards in VII and VIII* (?). *Spermiducal glands of XVII larger than those of XIX. Penial setae ornamented with ridges. Spermathecae with small diverticulum. Hab.—Runssoro, E. Africa.*

(31) Benhamia kafuruensis, MICHAELSEN.

B. kafuruensis, MICHAELSEN, loc. cit., p. 34.

Definition. *Length,* 45 *mm.; breadth,* 2 *mm.; number of segments,* 126. *Clitellum, XIII–XX* (?). *Prostomium and buccal segment very small, and withdrawn into mouth-cavity. Dorsal pores commence V/VI. Setae strictly paired. Gizzards in VIII, IX. Sperm-sacs in X, XI, XII. Penial setae end in a very fine point, not ornamented. Spermathecae with one diverticulum. Hab.—Kafuru, E. Africa.*

FAMILY EUDRILIDAE.

DEFINITION. **Oligochaeta of various size, with paired nephridia; spermiducal glands always present; sperm-ducts open into these glands at some distance from external orifice. Spermathecae (if present) impaired, and opening on to exterior in the neighbourhood of female genital pores, generally replaced by or, if present, enclosed in coelomic sacs, which are frequently connected with the other parts of the female reproductive system.**

This family of earthworms is one which has only very recently become at all known. It is undoubtedly, from many points of view, the most interesting family of Oligochaeta, principally owing to the remarkable structure of the reproductive organs. The family is, moreover, one which is distinguished by its geographical distribution. With the sole exception of the type-genus, *Eudrilus*, the family is restricted to the 'Ethiopian region,' being especially abundant in the equatorial portion of the African continent. For a long time *Eudrilus* was the only genus certainly known. More recently, ROSA, MICHAELSEN, and I myself have made known a considerable number of different genera of Eudrilidae.

Besides the genera and species referred to in the following pages, there is at least one of the genera described by KINBERG that in all probability belongs to this family; this is *Tritogenia.* It is thus defined by KINBERG (p. 98):—

'Lobus cephalicus transversus, brevis, longitudinaliter striatus; setae corporis anterioris dorsales singulae, ventrales binae, corporis posterioris nullae; tuberculum ventrale singulum.'

The species *Tritogenia sulcata* is defined in these words:—

'Segmenta 80, plurima biannulata; tuberculum ventrale segmenta 17–19 praebens; longitudo 55 mm.'

The species is from Port Natal, a likely locality for an Eudrilid. The chief reason which leads me to regard the worm as an Eudrilid is, of course, the unpaired male pore and its extent; I think it possible that KINBERG had before him a species of the genus *Polytoreutus,* in which there is an area of large extent before and behind the male pore; but the character is, indeed, one which might suit a good many Eudrilids. The facts given by KINBERG are, it is hardly necessary to state, not sufficient to fix the genus of the worm with any approach to correctness; it is not even absolutely certain that it is a member of the present family. It is said to have only six setae; this statement, if proved, would, of course, place it in a very isolated position; it is possible that the outermost seta was overlooked by KINBERG.

This group of worms contains species of all sizes; at one end of the series are such forms as *Reithrodrilus minutus,* which is barely two inches in length by one millimetre in breadth; at the other extremity we have the comparatively gigantic *Paradrilus rosae,* a big worm measuring a foot and a half in length.

In all the genera of the family the *setae* are paired, and are of the common sigmoid form found in the majority of the terrestrial Oligochaeta[1]. The individual setae of each pair may be nearer or further away from each other, but there are never more than eight of them in a segment.

The *dorsal pores* appear to be absent, except in *Platydrilus* and *Eudriloides.*

The *integument* very generally, though not always, contains peculiar bodies, possibly of a sensory nature, whose structure has been fully described on p. 16 above. These organs have never been met with outside this family. In many Eudrilidae the *oesophagus* is furnished with median ventral diverticula, unknown in any other group except in the genus *Gordiodrilus*, belonging to quite a different family. These diverticula, which were first made known by myself (in *Eudrilus*), are not simple pouches; the lumen is converted into a network of narrow canals by the folding and anastomosing of the lining epithelium; this may even be developed to such an extent as to produce in parts an intra-cellular lumen. Paired calciferous glands, in addition to these 'Chylus-taschen,' as they have been termed by MICHAELSEN, are commonly present; all of these structures may be absent; in *Libyodrilus*, for example, there are neither calciferous glands nor ventral diverticula. In other genera the calciferous glands are apparently represented by peculiar structures, whose minute anatomy and relations have been dealt with on p. 62.

Another highly characteristic feature in the organization of the Eudrilidae is a peculiar modification of the *excretory system*. This is not seen in all the genera of the family, but occurs in *Libyodrilus*, and, apparently in *Pareudrilus*, *Stuhlmannia*, and *Eudriloides*. The peculiarity consists in the formation of a network of complex character out of the nephridial ducts; this network traverses the body-wall, and there are numerous orifices into the exterior. Characteristic though it is of one family of the Oligochaeta, and of one family only, I have thought it necessary to regard this remarkable condition of the excretory system as of sufficient general importance to find a place in my general sketch of the organization of the Oligochaeta (see p. 44).

The most characteristic feature of the family, however, is the arrangement of the *genital organs*.

As in most other families of earthworms, we find species with only a single pair of testes, and other species, the majority, in which there are the more usual two pairs; exceptionally (in *Hyperiodrilus*) the testes are attached to the posterior wall of their segments, which are always the tenth and eleventh. Quite unique among Oligochaeta is the arrangement of the funnels and the first part of the sperm-ducts in certain forms; in *Eudrilus*, as was first described by myself, the

[1] In *Stuhlmannia variabilis* only is the free extremity ornamented.

sperm-duct, just where it leaves the funnel, is dilated to form a wide sac, spherical in form; shortly after this description, ROSA found the same dilation of the proximal part of the sperm-duct in *Teleudrilus;* it also occurs in *Hyperiodrilus, Heliodrilus,* and in a few others; in the latter genera, as well as in *Teleudrilus,* the sperm-duct perforates the septum, near to which it opens into the body-cavity, twice; the funnel, that is to say, is directed towards the external orifice of the sperm-duct, and away from the testes. The two sperm-ducts, if there are two pairs, never join until just at their opening into the spermiducal gland; in *Eudrilus* these ducts have a moderately thick muscular coat. The spermiducal gland is always present, and generally has a tolerably thick muscular covering, which is very well marked, for example, in *Eudrilus.* It is a very characteristic feature of this family that the sperm-ducts open into the gland itself, and not into its muscular duct, as is the case, for example, with the Perichaetidae and Cryptodrilidae; in no other family of earthworms, except *Moniligaster* and certain Geoscolicidae, has this state of affairs been found. I have commented upon it elsewhere (p. 105), in relation to the homology of the spermiducal glands throughout the entire group of Oligochaeta. The spermiducal glands commonly open on to the exterior through a terminal sac, which is not at all glandular, and is clearly, in many cases at any rate, eversible, forming thus a penis. Only in one species is the gland single; in all others there are two, which, however, open in the majority by a single pore; in *Eudriloides durbanensis* there is a single and medianly situate spermiducal gland; in this case, however, the cavity of the gland is divided by a longitudinal septum.

Peculiar to the Eudrilidae, and apparently confined to the genera *Eudriloides* and *Notykus* are certain glands connected with the spermathecal sac. These occur in *Eudriloides cotterilli* and *E. brunneus,* and in *N. emini.* Their minute structure has been described in *Eudriloides* only.

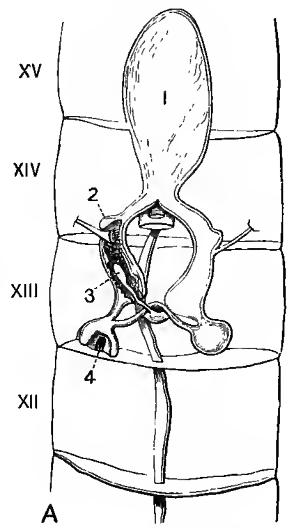
The ovaries in all Eudrilidae are placed in the thirteenth segment; they invariably lie attached to the anterior wall of that segment; there is, in fact, nothing in any way different from other earthworms in their position. It is, however, the case that the ovaries are not always recognizable in the sexually mature worm. Hence the exact position of these gonads is not quite certain in a few forms. In *Eudrilus* the ovaries can be readily found in the adult worm, but in *Libyodrilus* this is not so; there is no trace, or possibly only the merest trace, of ovaries in the mature worm; in the immature worm the ovaries are visible in the usual position; so, too, with *Polytoreutus violaceus,* and perhaps the other species of this genus; the ovaries have been with considerable uncertainty identified with masses of quite undifferentiated cells lying in the spermathecal sac. The inconspicuous character of the ovaries in

so many Eudrilids is correlated with the fact, that in this family the ova undergo their whole development in the egg-sacs. The first description of the egg-sac of an Eudrilid was given by myself for *Eudrilus;* in this genus I described the egg-sac as an ovary, on account of the presence of germinal cells in all stages of development. A study of immature examples of *Polytoreutus kilindinensis* (**84**) showed that the ovary is apparently transferred to the egg-sac *en masse* before the germinal cells had commenced to become differentiated in the direction of eggs; in a young specimen of this worm the egg-sacs were filled with cells, unmistakably generative cells, while there was no clearly recognizable trace of an ovary.

In the simpler forms of the family the ovaries retain their freedom, and are in no way related to the oviducts; in the genera *Eudriloides*, *Platydrilus*, and *Megachaeta* (?) both the ovaries and the funnels of the oviducts hang freely into the thirteenth segment; in all other genera the ovaries are enclosed in a peritoneal sac. The complication of the system of peritoneal sacs surrounding the female reproductive organs varies in degree. The simplest form is *Eudriloides;* here the arrangement of the different organs is precisely as in other earthworms, except for the fact that the spermathecal sac opens on the thirteenth segment and is of considerable length. The next stage in the complication of the various organs concerned is seen in the genus *Platydrilus;* here we have, as already mentioned, the ovaries and the oviducal funnels quite free, but the oviduct appears to communicate with the median spermatheca; this matter requires looking into again, as the said communication was only seen in *Platydrilus lewaensis,* where no egg-sac was observed. In all other genera at present known, the formation of peritoneal sacs which enclose the female organs of reproduction have reached a greater degree of development. There are many differences of detail, but apart from these, which are described under the descriptions of the genera, we can distinguish two main types as it appears to me. In one series the ovaries are enclosed in sacs which are prolonged into a median spermathecal sac often surrounding the gut, and reuniting on the dorsal side of the gut into a backwardly directed sac of variable dimensions; these sacs do not communicate directly with the exterior on their own account; but they enclose and perhaps originally open into the egg-sac into which opens the funnel of the oviduct; within the peritoneal sacs lies a spermatheca which opens into the exterior in the middle line, but does not communicate with the peritoneal sac in which it lies. This type is represented by my genera *Hyperiodrilus* and *Heliodrilus;* it is exceedingly hard to understand how fertilization can take place in these two genera on the hypothesis (possibly a perfectly gratuitous one), that the method of procedure is as in the British *Lumbrici.* If sperm is emitted from one

individual into the spermatheca of the other, it cannot reach the ova of that individual, but must be transferred to another or conveyed into the cocoon. If we are to assume that fertilization is carried on in the way that has been studied in *Lumbricus*, the development of the large peritoneal sacs is unintelligible; perhaps the other genus in which the female reproductive system is constructed on a similar plan gives a clue; in *Heliodrilus* the spermatheca is very large; it reaches from its opening on the eleventh segment as far back as the thirteenth, and is only invested by a peritoneal sac at its very tip; the sacs in this genus are greatly reduced as compared with the last; it looks as if the gradual reduction of the spermatheca was accompanied by a growth in the investing sac of peritoneum. Turning to the remaining genera of the family, we find no one in which there are true spermathecae of the kind existing in *Hyperiodrilus* (see fig. 47), and *Heliodrilus;* in all of them the spermathecae are peritoneal sacs, which function as spermathecae because they contain sperm, but which open on to the exterior and are not closed sacs, as in *Hyperiodrilus* and *Heliodrilus*. The only exception to this statement is afforded by *Nemertodrilus;* in that genus the sacs in question open into the cavity of the thirteenth segment—no doubt an indication of their development from the septum xiii/xiv—but they communicate indirectly with the exterior by means of paired orifices on the floor of the thirteenth segment. Here, in fact, the orifices are quite independent of the sacs with which they must have some relation. The fact that the spermathecal sacs in the Eudrilidae are peritoneal structures was first suggested by myself in a paper dealing with the two genera *Hyperiodrilus* and *Heliodrilus;* I pointed out that *the sacs contain other organs*, e.g. the true spermathecae; later, I found that the development of the corresponding sac in *Libyodrilus* was, undoubtedly, from the intersegmental septa like the development of the sperm-sacs; it was necessary, therefore, to regard these sacs as peritoneal and the contained cavity as coelomic; later still, Rosa indicated the difference in the character of the lining epithelium of these sacs, and of their duct leading to the exterior; the latter represents all that is left of the true spermatheca; the extent of the part of the whole spermathecal sac, which is developed as an invagination, differs in different genera.

Fig. 47.

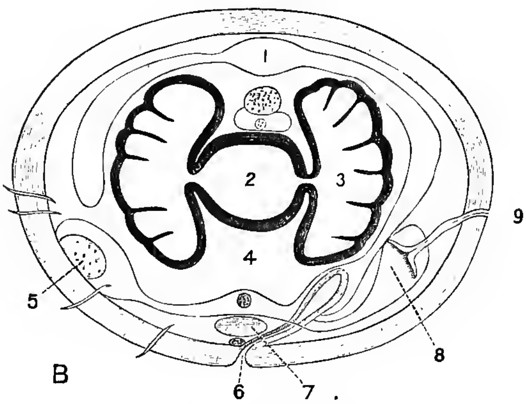


REPRODUCTIVE ORGANS OF (FEMALE) HYPERIODRILUS.

1. Spermathecal sac. 2. Egg-sac. 3. Spermatheca. 4. Ovary. The segments are numbered.

The structure of the spermathecae in the Eudrilidae forms also a very interesting illustration of the 'substitution of organs.' The group is distinguished, as has been shown, by the important fact that the organs, which, largely at any rate, serve the purpose of storing up sperm received from another individual, are coelomic sacs, not, as in all other Oligochaeta, invaginations of the epidermis. There is, however, some evidence which goes to prove that these sacs have gradually taken the place of organs constructed on the plan which characterizes the vast majority of the Oligochaeta. The various genera of Eudrilidae can be arranged in a series which illustrates this gradual substitution. The first term in the series is, perhaps, represented by the genus *Heliodrilus;* here there is a long spermatheca which reaches from the eleventh segment, where the external pore is placed, as far back as the thirteenth. The spermatheca is expanded at the blind extremity, and the extreme tip is again narrowed; the very end of the sac is enclosed in a sac of peritoneum, which is itself enclosed in a larger sac, communicating with the ovarian sac, &c.; in sections the columnar epithelium lining the spermatheca can be easily distinguished from the peritoneal cells lining the sacs which partly enclose it. This, however, is the only reason which leads to the inference that the organ which I have called the spermatheca is really strictly comparable to the spermathecae of other Oligochaeta. It might be considered a proof that the spermatheca lies in a coelomic sac; but the fact that there are two sacs of that nature, one enclosing the other, shows that it is necessary to be careful in drawing such an inference. In the allied genus *Hyperiodrilus* (figs. 47 and 48) the spermatheca is not evident on a dissection of the worm; it is a small elongated sac which lies in the interior of a large sac which surrounds the gut, and is prolonged backwards above the gut as a pouch of oval contour and considerable size; on a dissection it appeared as if it was this large sac which opened directly on to the exterior; but this appearance is shown to be due to the fact that the sac in question closely invests the real spermatheca up to the very point of opening of the latter. In the genus *Hyperiodrilus,* therefore, there is a great reduction of the spermatheca, coupled with a great increase of the coelomic sac which surrounds it. So many of the genera of Eudrilidae are imperfectly known, as regards their minute anatomy, that a stage immediately following this is not at present forthcoming; the nearest appears to me to be *Paradrilus;* in this genus, as ROSA has pointed out (35), the spermathecal sac is not an invagination from the exterior, but is a coelomic sac, which communicates with the exterior by a narrow tube, the epithelium lining which is manifestly epidermic in origin; in transverse sections the abrupt change in the character of the cells can be seen; I infer that the epidermis-invagination is the remnant of the spermatheca of such forms as *Hyperiodrilus* and *Heliodrilus.* In *Eudriloides* there is a still lower, or, rather, a more specialized, condition; in this genus, at any rate in two species, *E. cotterilli* and *E. brunneus,*

Fig. 48.



TRANSVERSE SECTION THROUGH SEGMENT XIII OF HYPERIODRILUS.

1. Spermathecal sac. 2. Oesophagus. 3. Calciferous glands. 4. Body-cavity. 5. Ovary. 6. Spermathecal pore. 7. Nerve-cord. 8. Sac into which oviduct (9) opens.

which I have myself examined, there is a cup-shaped layer of cells which seem to be epidermic; they are not, however, continuous with the epidermis, so that there may be some mistake in the interpretation which I advance here and have advanced before (**84**); this layer of cells does not, as does the corresponding layer in *Paradrilus*, immediately surround the lumen of the large spermathecal sac; the cells of the latter, which seem from their resemblance to the cells in the spermathecal sac of *Hyperiodrilus*, &c., to indicate a mesodermic origin for the sac in question, are continued right on to the external pore, forcing their way between the epidermic cells, which they have pushed aside. The last stage is, perhaps, shown by the genera *Libyodrilus* and *Polytoreutus;* in the former, at any rate, there seems to be but the merest trace, if any, of an epidermic invagination to meet the spermathecal sac; the latter I have shown to be of mesodermal origin; in sections through a non-mature individual of *Libyodrilus* I found the spermathecal sac, as it were, burrowing its way through the muscular layers of the body-wall on its way to reach the exterior. In *Polytoreutus* also there can be but little of the spermathecal sac which is of epidermic origin. We have, therefore, a series showing the gradual decrease in importance of the spermathecae and their replacement by a large coelomic sac which serves the same purpose.

MICHAELSEN has divided the Eudrilidae into two subfamilies—Eudrilini and Teleudrilini. The latter he defines as follows:—

'Die Teleudrilinen sind meganephridische, mit 4 Borstenpaar-Reihen ausgestattete Terricolen, die eine einzige, ventral-mediane männliche Geschlechtsöffnung auf oder am 17. Segment und eine einzige ventral-mediane Samentaschen-Öffnung hinter der Intersegmentalfurche 10/11 besitzen.'

The only distinguishing mark of the subfamily is therefore the unpaired character of the sexual apertures; in the other points mentioned there are no differences from the Eudrilini (of which MICHAELSEN gives no definition). Our knowledge of other Oligochaeta seems to me to render it unwise to attempt to make a wide distinction on the grounds of the paired or unpaired condition of the generative apertures. The genus *Fletcherodrilus* would hardly be constituted a representative of a distinct subfamily of the Cryptodrilidae by reason of its unpaired orifices. To speak of the Teleudrilini as a 'zweifellos "natürliche" Gruppe' is to my mind far too strong an expression. The unpaired genital orifices would be a matter of greater importance, if they were invariably associated with other anatomical differences. This is, however, by no means the case. A glance at the following tabular statement of the main structural features of the Eudrilidae indicates a better line of division.

I have already advanced this view of the affinities of the different genera (**84**). In the genus *Eudrilus* there are a number of anatomical peculiarities which distinguish it from other earthworms; in the first place, of course, the remarkable structure of the female reproductive system; secondly, the opening of the sperm-ducts into the glandular part of the spermiducal gland—a relation met with in no 'earthworm' except in the Moniligastridae. Apart from these characters which *Eudrilus* shares

GENUS.	SETAE.	CLITELLUM.	DORSAL PORES.	GIZZARD.	CALCIFEROUS GLANDS.	SENSE ORGANS OF INTEGUMENT.
Platydrilus . . .	paired, or more distant posteriorly	xiv–xvii	+	v	o	?
Megachaeta . . .	paired, ventral larger	?	o	v	o	?
Reithrodrilus .	paired	?	o	v	?	?
Stuhlmannia . .	,,	xiv–xvii	o	v	represented by modified glands	o
Metadrilus . . .	,,	xiii–xviii	o	v	o	?
Notykus	,,	xiv–xvi	o	v	?	?
Polytoreutus . .	paired, lateral closer together	xiii (xiv)–xviii	o	v	unpaired in ix–xi, paired in xiii.	+
Preussia . . .	,,	xiii–xviii	o	o	paired in xii	?
Paradrilus . .	,,	xiii–xviii	o	vii, viii	paired in xii, unpaired in x, xi (not always ?)	
Teleudrilus . . .	,,	xiv–xvii	o	vii, viii	unpaired in ix–xi, paired in xiii	+
Libyodrilus . . .	paired	xiv–xvi	o	xxiii–xxv	o	o
Hyperiodrilus . .	paired, lateral closer together	xiv–xvii	o	xviii–xxiii	unpaired in ix–xi, paired in xiii	
Eudrilus . .	paired	xiii–xvii	o	vi	,,	+
Nemertodrilus . .	,,	xiii–xviii	o		o	o
Eudriloides . .	,,	xiii–xviii	+ or o		represented by vascular structures in vi–xii	o
Pareudrilus . .	,,		o		o	o
Alvania	paired, lateral closer together	xv–xvi	o	xviii–xxii	unpaired in ix–xi, paired in xiii	+
Eminoscolex . .	,,	xiii–xviii	o	vi	,,	?
Unyoria	paired			v	?	?

with all the Eudrilidae, the genus *Eudrilus* differs from some other Eudrilidae in the four following characters:—

(1) The integument has numerous sense (?) organs, very like Pacinian bodies.

(2) The sperm-ducts dilate into a wide chamber just before they open into the funnels.

SPERM FUNNELS.	SPERMIDUCAL GLANDS.	SPERMATHECAL SACS.
opposite testes without swollen vesicula seminalis	open on xvii/xviii ; penial setae	single pouch, opening on xiii ; not enclosing ovaries
?	,, ,,	single pouch, opening on xiii
?	single, open on xvii/xviii ; penial setae ; also on xv, xvi	,, ,,
opposite testes without vesicula	open on xvii/xviii ; also a single tube connected with a penis ; penial sotae	single pouch, opening on xiii ; also an annular sac surrounding this and enclosing ovaries
opposite testes	open on xvii ; two protrusible penes, with rudimentary penial setae	ring-shaped sac, opening on xiv/xv and enclosing ovaries
single, opposite testes	open on xvii ; penial setae	single pouch, opening on xiii.
single, behind testes with dilated vesicula	open on xvii ; no penial setae	very complicated, enclosing ovaries
	open on xvii ; penial setae	single pouch, opening on xv
with dilated vesicula	open on xvii/xviii ; penial setae present or absent	single. opening on xiii, giving off lateral pouches which are connected with ovarian sacs and open into gut
with dilated vesicula, behind testes	open on xix ; no penial setae	two sacs, opening on xiii, connected with ovaries
opposite testes	open on xvii/xviii ; penial setae	one sac, opening on xiii, surrounding gut and enclosing ovaries
with dilated vesicula, behind testes	open on xvii ; no penial setae	one sac surrounding gut, and connected with ovaries enclosing a true spermathecae
with dilated vesicula	paired, open on xvii ; no penial setae	two sacs ; paired apertures connected with ovaries
without vesicula seminalis	paired, xvii/xviii ; no penial setae	two sacs completely separate from orifices on xiii ; ovaries free
without vesicula seminalis ; single pair	xvii ; penial setae ; walls often muscular	spermathecae opens on xiii ; ovaries free
without vesicula seminalis	paired on xvii ; walls muscular ; penial setae	paired on xiv/xv ; ovaries enclosed in a sac communicating with them
with dilated vesicula	open, xvii/xviii ; no penial setae	open on x ; ovaries enclosed
,, ,,	,, ,,	paired, surrounding end of a true spermathecae ; ovaries enclosed
?	open, xvii ; no penial setae	paired ; ovaries enclosed

(3) There are unpaired calciferous pouches in the segments immediately anterior to that in which a pair of calciferous glands lie.

(4) Nephridiopores paired on each segment.

These same characters are met with in *Polytoreutus*, *Teleudrilus*, *Hyperiodrilus*, *Heliodrilus*, and possibly in *Paradrilus* and *Preussia*. In the two last-mentioned

genera it is not known whether the integumental sense-bodies are or are not present; in *Preussia* the structure of the calciferous gland has only been described in *Preussia lundaensis*, which MICHAELSEN only doubtfully refers to the genus; they are stated by him to be like those of *Polytoreutus coeruleus*. In *Preussia siphonochaeta* the existence of a pair of calciferous glands in segment xii is rather doubtfully affirmed. The query, however, appears to refer not to the existence of the glands so much as to their function; for MICHAELSEN discovered no calcareous particles in them. The position of *Preussia* remains doubtful on account of the absence in MICHAELSEN'S papers upon the two species of this genus of any mention of the presence or absence of the dilated sac upon the sperm-duct, which he terms 'Eiweisskapseln.' The funnels in *Preussia siphonochaeta* are said to be very large and to occupy nearly the whole of the space within the sperm-sacs; this suggests rather that the funnels are more like those of such a genus as *Stuhlmannia* than *Polytoreutus*, where the funnels are small. In *Preussia lundaensis* the male efferent apparatus was not developed. All these genera with the exception of *Eudrilus* furthermore agree in the arrangement of the setae; in all, with the exception noted, the lateral setae are much closer together than the two setae of the ventral pair. The remaining genera of the family agree, with one exception to be referred to presently, in the following characters—largely the negatives of the characters which distinguish the first group; they are these:—

(1) Integument without the peculiar sense organs (except in *Eudriloides durbanensis*).
(2) The sperm-ducts show no dilatation.
(3) Calciferous glands, either absent or, if present, consist of a large series of paired organs different in structure from those of other Eudrilidae.
(4) Nephridiopores on each segment generally numerous.

The genera which certainly show these characters are *Stuhlmannia, Nemertodrilus, Libyodrilus, Pareudrilus*, and *Eudriloides*, with the sole exception of *Eudriloides durbanensis;* this species has the integumental sense organs, but agrees with this second group in the remaining characters. In addition to these *Platydrilus, Metadrilus, Megachaeta, Reithrodrilus, Notykus*, seem to have no dilatations upon the sperm-duct and no calciferous glands; but we have no information as to the other character. It is possible that the above statement is not quite accurate; for MICHAELSEN has recorded in *Megachaeta tenuis* a series of peculiar organs like fat-bodies along the sides of the gut. These seem to extend as far as the twentieth segment; it is very possible that they correspond to the structures described by myself in *Stuhlmannia* and *Eudriloides* (see below). As regards character No. 4

it is less certain how far it is widely spread. In *Libyodrilus*, as is pointed out more in detail elsewhere, there is a complicated integumental network formed by the branching and anastomosis of nephridial ducts. I have discovered at least traces of a similar network in *Pareudrilus*, *Eudriloides*, and *Stuhlmannia*. MICHAELSEN'S failure to find nephridiopores in other forms may very possibly be an indication of a similar state of affairs. On the other hand, there is no trace of this network in *Eudrilus*, or any member of the first group. If we are to accept MICHAELSEN'S division of the family, *Pareudrilus* would have to be placed by the side of *Eudrilus* and *Nemertodrilus*. This would be a very heterogeneous assemblage; but the violence which would be done to the affinities of the genera in question by this unsuitable collocation will be more apparent after the mutual relationships of the different genera have been discussed.

MICHAELSEN places the genus *Eudriloides* at the base of the series. In this genus the ovaries remain unenclosed within sacs, and there is no communication between the spermathecal sac and any other part of the female apparatus; to this might be added the fact that there are—occasionally at any rate—dorsal pores. The development of other Eudrilidae in which there is a complicated system of coelomic sacs enclosing the ovaries shows that this state of affairs is secondary; but to show this it is not necessary to have proved that the simpler forms are more primitive. This, however, is undoubtedly one point in which *Eudriloides* resembles other Oligochaeta more than does any other genus of Eudrilidae. I have previously referred to the gradual change in the character of the spermathecae in this group (p. 578). Spermathecae like those of other Oligochaeta seem to have been replaced by spermathecae which are coelomic sacs; and there is a series of stages in this replacement. Here, as elsewhere, it might be argued that the change has been in the reverse direction to that which has been suggested. The principal argument to the contrary is, of course, the vast preponderance of families in which the spermathecae are epidermic invaginations; indeed there are no other forms except the Eudrilidae in which these organs are not entirely formed in this way. In this case those Eudrilidae in which the replacement has not commenced, or has only just commenced, will be so far the most primitive forms; assuming this for the moment, it is clear that *Heliodrilus* is the most primitive Eudrilid. Moreover, in this genus, as in the group of genera round it, the calciferous glands are more like those of other earthworms than are the peculiar structures of *Eudriloides;* these latter are more easily to be derived from calciferous glands of the ordinary type than are the typical calciferous glands from them (see p. 62). Their number too and the segments in which they occur are more like what is usually met with in other Oligochaeta. On the other hand,

the dilatations on the sperm-ducts and the peculiar sense organs of the integument which also characterize these genera are absolutely distinctive of them and have not their counterpart in any other group of Oligochaeta.

We can hardly escape from the difficulties of arranging the various genera of Eudrilidae in their relative positions by the assumption that the family is diphyletic —a proceeding which often affords relief to the perplexed systematist. In spite of the well-marked differences which divide certain genera, and which may allow of their being divided into two subfamilies, there is too broad a basis of agreement for any such course to recommend itself; it does, however, appear that the group which is represented by *Stuhlmannia* and its immediate allies, has arisen from the main stem near to its root, before some of the characteristic features of the other group have been produced; I refer more particularly to the median oesophageal pouches, and to the integumental sense organs. If this view be adopted the primitive form of Eudrilid may be supposed to have possessed a series of paired calciferous glands occupying a number of segments, a single or perhaps two spermathecal pouches, opening on to the exterior on the thirteenth segment or thereabouts, of epidermic origin, in fact, showing those characters which now are common to the two subfamilies of the Eudrilidae. In this primitive form we must assume that there was no development of sacs surrounding the ovaries. *Eudriloides* and *Platydrilus* will be the nearest to the ancestral form on one line; on the other line of development there is no form left which stands near to the ancestor; the nearest should be, as I have already suggested, *Heliodrilus*. We must, therefore, I consider, place the Eudrilidae in two parallel lines.

Affinities of Eudrilidae.

The relationships of the Eudrilidae to other families of Oligochaeta are not at all plain. Rosa at first included them with what I term here the Cryptodrilidae; but at the time when he wrote the only Eudrilid known was *Eudrilus* itself; the existence of only a single abnormal genus might reasonably be held to render a further division unnecessary. This view of the affinities of the Eudrilidae was, however, adhered to by Benham (1) a year or two later. It is now agreed that the Eudrilidae form a distinct family. This being so, what are their affinities? We may clear the way by placing in a tabular form the salient peculiarities of the family. The Eudrilidae, to a greater or less extent, are distinguished by the following characters restricted to themselves:—

(1) The presence of sense organs (?) like Pacinian bodies in the skin.

(2) The degenerate calciferous glands in certain forms and the unpaired pouches of others.

(3) The integumental nephridial network of *Libyodrilus*, &c.

(4) The presence of a single spermatheca placed in the neighbourhood of the ovaries.

(5) The presence of coelomic pouches functioning as spermathecae in many forms, and in others enclosing the ovaries.

(6) The sometimes dilated extremity of the sperm-duct, and the position of the funnels with reference to the septa.

The above structural features are absolutely confined to the Eudrilidae in the form in which they occur; Nos. 2, 3, 4, however, are only partially distinctive. My genus *Gordiodrilus* has a single pair (for one only) of ventral pouches, whose structure is not unlike the modified calciferous glands of such a form as *Stuhlmannia* (see p. 62). In *Acanthodrilus*, and possibly in other worms with a diffuse nephridial system, the tubes branch within the body-wall, but this is never correlated with paired nephridia as it is in the Eudrilidae. The position of the spermathecae in the vicinity of the ovaries is also found in many Geoscolicidae. A few other characters of the Eudrilidae are not so restricted to that group, although very characteristic; they are:—

(1) The opening of the sperm-ducts into its glandular appendage.

(2) The existence of a penis (or penes) which are permanent processes of the body-wall.

(3) The generally unpaired generative orifices.

(4) The presence of a number of gizzards at the junction of the oesophagus with the intestine.

The above characters occur in several species; besides these there are a few other characters which are each confined to a single genus or species, and which are rarely met with elsewhere. Such are:—

(1) The spermatophores of *Polytoreutus*.

(2) The peculiar glands appended to the base of the spermatheca of certain species of *Eudriloides* and *Notykus*.

(3) The disappearance of the ovary in mature forms (*Libyodrilus*, &c.).

(4) The ciliation of the spermiducal gland in *Eudriloides*, &c.

The opening of the sperm-ducts into the spermiducal gland is a character which is shared by the Eudrilidae with practically all the lower Oligochaeta, and with the Moniligastridae among those families placed by Rosa and by others in the group Terricolae. It is noticeable, however, that when a similar gland—always reduced in

size—is present in the Geoscolicidae, the sperm-duct opens on to the exterior through it; this appears to be the case, for example, with *Geoscolex* itself and with *Kynotus*. The minute structure of the gland in *Geoscolex* is not known; but it has been described (unfortunately without figures) by Rosa in *Kynotus michaelsenii*. The same kind of apparatus exists in *K. madagascariensis* also (Michaelsen, **10**). In both the homologue of the 'prostate' ends in a Bursa propulsatoria. Rosa showed that the sperm-duct penetrated the wall of the bursa, and then ran within the walls of the glandular appendix (the 'prostate') opening into the lumen of the latter. This is almost exactly what is found in the Eudrilidae; there is a bursa into which opens the spermiducal gland proper (or glands); the sperm-duct or ducts open into the lumen of the latter. The fact that in *Kynotus* the epithelium lining the glandular appendix, or, as I prefer to call it, the spermiducal gland, is composed of two layers of cells renders a comparison with the corresponding structures of the Eudrilidae, lined as they are with a double layer of cells, obvious. On the whole, therefore, it appears that the terminal apparatus of the male ducts in the Eudrilidae is more like that of the Geoscolicidae, than it is like that of the Megascolicidae. The second point in the list of characters of the Eudrilidae which they share with some other worms is the presence of penes; these organs are not protrusible structures like, for example, the penis of certain Perichaetidae which are simply everted ducts; the only worms in which anything of the kind exists are the Lumbriculidae (*Stylodrilus* and *Alluroides* only), and, again, the Geoscolicidae; the genus of Geoscolicidae which shows this character is *Siphonogaster;* the two penes of that worm are outgrowths of the body-wall and not eversible processes. Another small point of resemblance between the two families is the frequently intersegmental position of the male pores. The gizzards of the genera *Heliodrilus*, *Hyperiodrilus*, and *Alvania*, situated at the end of the oesophagus resemble so far those of the Geoscolicid *Bilimba;* but as exactly the same thing is seen in *Pleionogaster*, this character is evidently not of so much weight. Of more weight is the position of the spermatheca in many Eudrilids in the neighbourhood of the ovaries; the only other Oligochaeta in which this occurs besides the Geoscolicidae (in which it is fairly common—in the subfamily Microchaetidae), are the Lumbriculidae; the resemblance of this latter family to others is, however, treated of on a subsequent page. As a final point of resemblance, may be mentioned, the elongated sperm-sacs of *Polytoreutus* to be compared with those of certain Geoscolicidae. The extreme tenuity of these sacs in *Polytoreutus finni* is to be specially compared with the very slender sacs of *Trichochaeta*.

On the whole, therefore, as it appears to me, the nearest allies of the Eudrilidae

are the Geoscolicidae; but I admit that they are separated by a considerable interval.

Subfamily Pareudrilinae.

Definition. **Integumental sense organs rarely present[1]. Sperm-ducts without dilatation; ducts of nephridia branching in body-walls; calciferous glands modified or absent.**

Genus EUDRILOIDES, Michaelsen.

Definition. **Setae strictly paired. Spermathecal pore on XIII or XIII/XIV. Male pore on XVII/XVIII. Ovaries independent of oviducts and spermathecal sac. Penial setae present.**

This genus is undoubtedly, as Michaelsen has pointed out, at the base of the series; the ovaries retain their primitive distinctness and are not in any way bound up with the rest of the female generative apparatus. The position of the median spermathecal sac and the characters of the spermiducal glands alone serve to indicate that the genus is to be referred to the family Eudrilidae.

The genus contains five species, all of which are East African in habitat. They are to be distinguished by the shape of the penial setae and by the genital papillae.

It is, perhaps, a little doubtful whether the two species, *E. cotterilli* and *E. brunneus*, are to be referred to the same genus as the three first. They differ in the absence of the dorsal pores (a most unusual character in the family Eudrilidae, and only found elsewhere in *Platydrilus lewaensis*), which occur in the three species described by Michaelsen: in the presence of glandular appendices to the spermathecal sac, like those of *Notykus:* finally, they differ, perhaps (see, however, under *E. titanotus*), in the presence of the peculiarly modified calciferous glands.

(1) Eudriloides gypsatus, Michaelsen.

E. gypsatus, Michaelsen, JB. Hamb. wiss. Anst., vii, 1890, p. 23.

Definition. *Length,* 130 *mm.; breadth,* $3\frac{1}{2}$ *mm.; number of segments,* 147. *Clitellum, XIV–XVII. Dorsal pores present from IX/X* (?). *Spermathecal sac opens on XIII, without glands. Penial setae bent into a hook at free extremity without denticulations. Hab.—Zanzibar and Kikota; E. Africa.*

[1] Only in *Eudriloides durbanensis.*

This species has been described by MICHAELSEN as of a brilliant white colour, which is, he thinks, due to the cuticle; it is not mentioned how the specimens were preserved, but the fact that the white colour is replaced by black when the worms were treated with alkali, is suggestive of corrosive sublimate. I have mentioned as a generic character that there are no sense organs in the integument—I refer, of course, to those characteristic bodies which are found in other genera of Eudrilids. MICHAELSEN, however, describes 'eine dichte Reihe grauer Pünctchen,' on the anterior segments, which may be these Pacinian corpuscle-like bodies. This species and the next are peculiar in the family Eudrilidae by reason of the presence of dorsal pores. The intestine commences in the thirteenth segment, and has a well-developed typhlosole; septa v/xi are thickened; the nephridia are stated (with a query) to open by the ventral setae. MICHAELSEN, in the two papers (**6**, **12**) referring to this species, has illustrated various points in its anatomy.

(2) Eudriloides parvus, MICHAELSEN.

E. parvus, MICHAELSEN, loc. cit., p. 15.

Definition. *Length*, 40 *mm.; breadth*, 1·1/3; *number of segments*, 98. *Dorsal pores present. Clitellum, XIV–XVIII. Genital papilla on XIX. Spermathecal pore on XIII. Penial setae without ornamentation, pointed at end. Hab.—Quilimane.*

This species was studied from a single example only; hence the account of its structure given by MICHAELSEN is in many respects incomplete.

(3) Eudriloides titanotus, MICHAELSEN.

E. titanotus, MICHAELSEN, loc. cit., ix, 1891, p. 10.

Definition. *Length*, 60 *mm.; breadth*, 2 *mm.; number of segments*, 155. *Dorsal pores present. Clitellum, XIV–XVII. Spermathecal pore on XIII, without glands. Penial setae with a narrow ridge on either side at extremity, which is irregularly denticulate. Hab.—Zanzibar and Kinngasi.*

This species has the same white coloration as has the first species of the genus, and alkalis produce the same alteration in its hue; the prostomium, unlike that of the last two species, has no prolongation on to the buccal segment. MICHAELSEN is doubtful whether the clitellum does not commence with the eleventh segment; at any rate, this and the two following segments were 'etwas modificirt.' The intestine begins in the sixteenth segment; septa v/xi are thickened.

(4) Eudriloides cotterilli, BEDDARD.

E. Cotterilli, BEDDARD, Q. J. M. S., vol. xxxvi, 1894, p. 204.

Definition. *Length, about an inch. Clitellum, XIV–XVII. Genital papillae on XI and a pair behind male pore. Spermathecal pore on XIII/XIV, with glands at each side. Penial setae with two rows of denticulations at free extremity. Hab.—Kilindini.*

This species differs in several points from the last three. It has in the first place six pairs of glands which appear to be the metamorphosed equivalents of the calciferous glands; perhaps, however, such glands are also present in *E. titanotus*. I could not find any dorsal pores. The clitellum is saddle-shaped, the ventral median area being chiefly occupied by the prominent generative pores; the ventral pair of setae are absent from the thirteenth segment, and no setae at all were to be discovered on the clitellum. The two sperm-duct funnels are united above the nerve-cord; they open near to the distal end of the spermiducal glands, which are provided with two muscular layers of some thickness.

(5) Eudriloides brunneus, BEDDARD.

E. brunneus, BEDDARD, loc. cit., p. 212.

Definition. *Length, about four inches. Clitellum, XIV–XVII, saddle-shaped. Median genital papillae on XIV, XIX/XX, and a pair of papillae on XVI. Spermathecal pore on XIII, with glands. Penial setae thin off at extremity without denticulations. Hab.—Kilindini, E. Africa.*

This species cannot be confounded with any other; the genital papillae differ from those of the rest of the members of this genus. The existence of the pear-shaped glands on either side of the bursa of the spermathecal sac ally this species rather to the last than to others of the genus. The spermathecal sac too is prolonged beyond the external orifice, and this region has a lumen which is complicated by the presence of numerous folds.

(6) Eudriloides durbanensis, BEDDARD.

E. durbanensis, BEDDARD, P. Z. S., 1892, p. 696.

Definition. *Length, about 50 mm.; breadth, 2 mm. Clitellum on XIV–XVII. Genital papillae paired on XI, XIII (two pairs), XV. Spermathecal pore on XIII. Spermiducal glands contained within one sheath. Hab.—Durban.*

I refer this species, with some doubt, to the genus *Eudriloides*. When I first examined it I was inclined to regard it as a *Notykus*. The similarity to that genus is in the presence of a sac which encloses the ovaries and the distal end of the spermathecal sac. The resemblance, however, to MICHAELSEN'S description and figure of the female generative organs of *Notykus* is possibly only apparent; for in the present species the sac is merely produced by a junction between the septa xii/xiii and xiii/xiv. It is not a separate sac as it probably is in *Notykus;* but, as MICHAELSEN has remarked in describing *Notykus emini* that he was unable to make out fully the generative organs in that species, it is a possibility that must not be lost sight of that that worm is also an *Eudriloides*. The principal argument against placing the present species in the genus *Eudriloides* is because it has in the epidermis the 'Pacinian bodies' which do not occur in other forms. Another difference is the fact that the two spermiducal glands are contained within a common sheath and that they are covered by a thin peritoneal layer only instead of by the thick muscular layers that are found in, at any rate, the two last species of *Eudriloides*. The form of the penial setae is unfortunately unknown.

Genus REITHRODRILUS, MICHAELSEN.

DEFINITION. Setae strictly paired. Male pore on XVIII. Spermiducal gland single, with one sac of penial setae. Spermathecal pore on XIII.

This genus is unfortunately only known by a single, and that an incompletely mature, individual. The above definition, however, is sufficient to distinguish *Reithrodrilus* from any other Eudrilid.

The prostomium has no dorsal prolongation.

The alimentary canal has a gizzard in v. Nothing is said about the calciferous glands or other structures connected with the alimentary canal. There is only a single spermiducal gland and a single sac of penial setae corresponding to this. The two segments in front of that which bears the male pore, i. e. the fifth, sixteenth, and fifteenth, have each a single median copulatory papilla; with this papilla is connected a pair of sacs of setae precisely similar to the penial setae. Of the female organs only the spermathecal sac was seen. This is a long sac extending back as far as the male pore.

Reithrodrilus minutus, MICHAELSEN.

R. minutus, MICHAELSEN, JB. Hamb. wiss. Anst. ix, 1891, p. 21.

Definition. *Length*, 45 *mm.*; *breadth*, 1 *mm.*; *segments*, 96. *Penial setae with transverse rows of denticles at extremity. Hab.—Malakalla, E. Africa.*

This species is the smallest known Eudrilid. The setae are very delicate, and the distance between the four pairs is equal. There appears to be but little pigment in the skin since the colour is described as being yellowish in front and grey behind.

Genus MEGACHAETA, MICHAELSEN.

DEFINITION. **Setae gradually diminishing in size dorsally, those nearest ventral median line being largest. Male genital pore upon XVII. A single median spermathecal sac opens on to segment XIII. Penial setae present.**

This genus is at present only imperfectly known, none of the examples of either of the two species having been fully mature. These two species—*Megachaeta tenuis* and *M. alba*—are both East African.

The most marked external peculiarity concerns the setae. The ventral setae are much stouter than the dorsal, and there is a regular diminution in size in passing from the ventralmost seta to the dorsalmost. Moreover in the anterior segments the setae are not so large as in the following segments. The characters of the setae are curiously paralleled in the genus *Gordiodrilus* (which see), which is not in other respects a near ally of the present worm. MICHAELSEN remarks that the nephridiopores are not visible. It may be that this genus, like *Libyodrilus*, has an integumental plexus; but we have no knowledge upon the point. The alimentary canal has a gizzard in segment v or vi; it appears to have neither calciferous glands nor ventral diverticula; the genital organs are also imperfectly known. In *Megachaeta alba* only a single pair of sperm-duct funnels were found lying in segment xi. The spermiducal glands are tubular and each has a sac of penial setae; or rather a single seta belongs to each. The aperture upon the thirteenth segment leads into a sac, which extends back as far as the seventeenth segment. This sac gives off lateral outgrowths which communicate with compact glands attached to the septa. The nature of these is at present very doubtful, and they are not very fully described by MICHAELSEN. The following is his description:—

'Durch die Oeffnung im 13. Segment gelangt man in ein grosses muskulöses, sich auch etwas nach vorne ausdehnendes Atrium. Nach hinten setzt sich dieses Atrium in eine lange unregelmässig angeschwollene und gekrümmte Samentasche fort, die sich bis in das 17. Segment erstreckt. Auch die Samentasche ist muskulös, besonders ihr distaler Teil. Seitlich und unterhalb des Atriums und des distalen Samentaschenendes haben sich starke Wucherungen gebildet, die bei einem ziemlich unreifen Exemplar flügelförmig in die Leibeshöhle hineinragten. Bei einem weiter ausgebildeten Exemplar zogen

sich diese Flügel vorne in dicke, gekrümmte Stränge aus, die mit einer eigenartigen Drüse in Verbindung standen. Auch das unreife Exemplar zeigte schon die Anlage dieser Drüsen, doch waren sie noch unabhängig vom Geschlechtsapparat. Diese Drüsen sind Wucherungen des Dissepiments 11/12. Sie bestehen aus vielen, nierenförmigen Teilstücken, die durch einen ziemlich dicken Kanal verbunden sind. Die nierenförmigen Teilstücke sind ziemlich kompakt und besitzen nur ein kleines Lumen. Diese Drüsen mit dem sie verbindenden Kanal ziehen sich seitlich vom Darm an dem betreffenden Dissepiment in die Höhe. An einem Exemplar erschien es mir, als ob sie oberhalb des Darmes zusammen trafen, ihn also ringförmig umfassen. Wenngleich die mit den Kanälen zusammenhängenden, von der flügelförmigen Wucherung des Atrium ausgehenden Stränge noch vollkommen kompakt erscheinen, so ist es mir doch nicht zweifelhaft, dass sie die Ausführungsgänge jener Drüsen zu bilden haben. Auch die Anlage der Drüsen (bei dem unreifen Exemplar) ist vollkommen kompakt. Das Lumen der Kanäle bildet sich erst später aus. Nach hinten scheinen aus der flügelförmigen Wucherung noch zwei Stränge auszutreten; doch liess sich nicht erkennen, zu welchen Organen sie sich ausbilden mögen (Ovarialsäcken ?).

The oviducal funnels lie freely in the thirteenth segment and are not enclosed as in other Eudrilids; but this may be merely a matter of age.

(1) **Megachaeta tenuis,** MICHAELSEN.

M. tenuis, MICHAELSEN, JB. Hamb. wiss. Anst., ix, 1891, p. 17.

Definition. *Length,* 120 *mm.; diameter,* 1 *mm.; number of segments,* 160. *Penial setae smooth, flattened at free extremity, and crescentic in section. Hab.—Korogwe, E. Africa.*

(2) **Megachaeta alba,** MICHAELSEN.

M. alba, MICHAELSEN, loc. cit., p. 19.

Definition. *Length,* 170 *mm.; diameter,* 3 *mm.; number of segments,* 154. *Penial setae smooth with a pair of wing-like processes forming a hood to free extremity. Hab.—Mbusini, E. Africa.*

Genus METADRILUS, MICHAELSEN.

DEFINITION. Setae strictly paired. Clitellum saddle-shaped, XIII–XVIII. Male genital pore on XVII. Two retractile penes with rudimentary penial setae. Spermathecal orifice XIV/XV, communicating with two short tubes, opening into large ovarian sacs.

Metadrilus consists, at present, of but a single species, described a short time since by MICHAELSEN, from Eastern tropical Africa. Its structure is in several

respects interesting; as in all the Eudrilidae the main interest naturally centres in the reproductive organs.

There are the usual two pairs of testes present in segments x and xi. Sperm-sacs of a racemose form lie in the two segments xi and xii. Nothing is said as to the mode of connexion between the sperm-ducts and the terminal glands; the latter open into a common muscular sac, which communicates with the single external orifice upon segment xvii. Corresponding to each gland is a longish muscular tube, to the proximal end of which are attached retractile muscles; each of these tubes is filled with a granular mass—evidently the secretion of the gland. At the proximal end of the retractor muscles, where they become continuous with the musculature of the body-wall, is 'a slight outgrowth of finely-granular structure, and in this lie two small irregularly shaped horny bodies.' These are regarded by MICHAELSEN as rudimentary penial setae; and the muscular tubes with their retractors as penes; that this interpretation is probably correct is shown by the fact that in one individual they were protruded.

The female organs of generation are no less remarkable; the median opening of the spermathecal sac lies on the boundary line between segments xiv and xv; this orifice leads into a small sac from which arises on each side a short muscular canal; these are considered to be the spermathecae.

These tubes open into the interior of two large thin-walled sacs, which communicate with each other above the gut in the thirteenth segment. The large sacs are completely filled with developing ova, and are to be looked upon as particularly large ovarian sacs. These large pear-shaped ovarian sacs join the receptacula ovorum by means of a short tube, near to the opening of which into the ovarian sac opens also (into the ovarian sac) the oviduct. MICHAELSEN figures a slight swelling upon the 'ovarian sac' just in front of the receptaculum ovorum; I myself should be inclined to look upon this as the true ovarian sac, which has become, as in *Libyodrilus,* almost indistinguishable from the spermathecal sac owing to the disappearance of the narrow connecting canal, which is present, for instance, in *Polytoreutus.* The muscular tubes communicating with the external pore may possibly be true spermathecae (i.e. of epidermic origin).

In regard to other structures *Metadrilus* shows no important differences from other Eudrilidae; the absence of nephridiopores may perhaps be accounted for by the existence of an integumental plexus as in *Libyodrilus.* The strong gizzard is in v; the oesophagus has no caeca of any description; the intestine begins in xvi, and has no typhlosole.

Metadrilus rukajurdi, MICHAELSEN.

M. Rukajurdi, MICHAELSEN, JB. Hamb. wiss. Anst., ix, 1891, p. 28.

Definition. *Length,* 120 *mm.; breadth,* $2\frac{1}{2}$ *mm.; number of segments,* 178*; anterior segments triannulate. Anterior septa only slightly thickened. Hab.—Mbusini, Mangwalla, Mrogoro, Longa, E. Africa.*

Of this species, as of so many others, I must remark that I do not pretend that the above specific diagnosis will be of any permanent value. The colour is said by MICHAELSEN to be 'blue-grey' dorsally and 'yellowish-grey' ventrally. This applies to the alcohol-preserved specimens.

Genus NOTYKUS, MICHAELSEN.

DEFINITION. **Setae strictly paired. Clitellum, XIV–XVI. Male pore on XVII. On XIII opening of spermatheca; in front of this are the ovaries fused together, and surrounded by a sac which partially encloses spermatheca. Penial setae present.**

This genus, again, is unfortunately very imperfectly known. The female reproductive apparatus seems to be rather different from that of many other Eudrilidae; it is thus described by MICHAELSEN :—

'Die Gestaltung des weiblichen Geschlechtsapparats habe ich nicht vollständig klar stellen können. Eine sehr lange, unregelmässig gekrümmte Samentasche, deren Basalteil muskulös und zwiebelförmig verdickt ist, und die im übrigen einen dünnwandigen, unregelmässig angeschwollenen Schlauch darstellt, erstreckt sich vom 13. Segment bis in die Gegend der männlichen Geschlechtsöffnung nach hinten. Jederseits neben der Basis der Samentasche liegt ein kleines, muskulöses Polster. Die Bedeutung dieser Polster ist mir unklar. Sie sind wahrscheinlich mit einem Hohlraum versehen, welcher durch die oben erwähnten spaltförmigen Öffnungen neben der Samentaschen-Öffnung ausmündet. Grade vor der Samentaschenbasis, dicht hinter der Intersegmentalfurche 12/13, liegt ein breiter, kompakter Körper, der wohl als ventralmedian verschmolzenes Ovarien-Paar anzusehen ist. Dieser Körper hat das Aussehen eines Konglomerates verschieden grosser kugeliger Zellen (Eizellen verschiedener Entwickelungsstadien?). Er ist durch eine feine Membran fest an die Samentasche angepresst. Nach Abtrennung dieser Membran (Ovarialblase?) von der Samentasche klappt der Körper mit der Membran, mit der er in breiter Fläche verwachsen ist, nach vorne zurück. Sollte diese Deutung der verschiedenen Organe richtig sein, so hätten wir hier einen Fall vor uns, wie BEDDARD bei *Hyperiodrilus* fand, eine teilweise Umhüllung der Samentasche durch die Ovarialblase.'

If the suggestions here quoted prove to be correct, the spermathecal sac of the

genus *Notykus* will correspond, not to the sac of *Nemertodrilus*, *Stuhlmannia*, &c., but to the true spermathecae of other families of Oligochaeta. As, however, in any case the description of the organs given by MICHAELSEN is incomplete, it is perhaps not very useful to do more than record the known facts.

The male organs show no remarkable differences from those of other Eudrilidae; the two spermiducal glands open by a common muscular Bursa copulatrix, with which also communicate two sacs containing penial setae. There is only a single pair of sperm-ducts, with their funnels, and presumably only a single pair of testes to correspond.

The gizzard as in so many genera lies in segment v; nothing is said as to the presence or absence of calciferous glands, &c.

Notykus emini, MICHAELSEN.

N. Emini, MICHAELSEN, JB. Hamb. wiss. Anst., ix, 1891, p. 32.

Definition. *Length,* 100 *mm.; breadth,* 4–4½ *mm.; number of segments about* 108. *Septa V/X thickened. Penial setae with numerous wart-like processes on the distal extremity. Hab.—Longa, E. Africa.*

This species is, after preservation in alcohol, greyish to dark brown; the absence of all traces of nephridiopores may mean that, as in *Libyodrilus violaceus*, there is a system of integumental nephridial tubes.

Genus PAREUDRILUS, BEDDARD.

DEFINITION. **Setae paired. Male pores paired on XVII/XVIII. Spermathecal pores paired on XIV/XV. Ovarian sac large, communicating with spermathecal sac; egg-sac not communicating with spermathecal sac. Spermiducal glands with thick muscular walls; penial setae very long.**

This genus of Eudrilidae, as is the case with so many others, has but one species, which is a native of East tropical Africa. It is one of the very few genera in which the reproductive organs are paired with paired orifices. The most remarkable feature of the genus is the fact that the ovaries appear to be enclosed in sacs, but that the egg-sacs are not related to the spermathecal sacs, as are the ovarian sacs No other genus shows this combination of characters.

Pareudrilis stagnalis, BEDDARD.

P. stagnalis, BEDDARD, Q. J. M. S., vol. xxxvi, 1894, p. 221.

Definition. *Length, 63 mm.; breadth, 4 mm. Penial setae with membranous expansion at tip, in front of which are minute denticulations. Hab.—Mombasa, E. Africa.*

The specimens of this species were obtained by Mr. FINN from a pond on the mainland opposite to Mombasa Island. The setae were developed upon all the segments of the body after the first except the ventral setae of the seventeenth segment. The gizzard lies in vi; there are seven thick septa after the gizzard. The colour is a dark purplish blue more marked upon the dorsal surface. The prostomium is prolonged for a very short distance on to the buccal segment. The intestine begins in the seventeenth segment and has a small typhlosole.

Genus UNYORIA, MICHAELSEN.

DEFINITION. **Setae paired. Male pores paired on XVII. Gizzard in VI. The female generative apparatus is also paired. The ovaries are enclosed each in a sac which communicates with ovarian sac and egg sac. From the junction of the two is a narrow stalk which widens into a large spermathecal sac. The latter opens on to exterior, close to junction with it of narrow tube, on segment XIV. No penial setae.**

This genus evidently comes very near to *Pareudrilus.* When more species of both are known it will probably be necessary to unite them. For the present I leave them apart. It is not certain that I am right in placing the genus among the Pareudrilini. I infer that this is its proper position since no mention of calciferous glands is made by MICHAELSEN and no reference to the dilatations upon the sperm-ducts or to the nephridiopores, all of which tend to prove the affinity of the present genus with *Pareudrilus*, &c.

Unyoria papillata, MICHAELSEN.

U. papillata, MICHAELSEN, Thierwelt Ost-Afrik., Regenw., 1894, p. 11.

Definition. *Clitellum, XIII–XVII. Paired papillae upon XV, XVI, XVIII. Hab.—Kassenge on Bank of Albert Nyanza.*

Genus PLATYDRILUS, MICHAELSEN.

DEFINITION. Setae paired, the setae wider apart at the two ends of the body and larger than at the middle. Clitellum saddle-shaped, XIV–XVII. Male pore on XVII. Ovaries unenclosed by a sac. Single median spermathecal sac, opening on XIII, communicates by a tube on each side with the oviduct. Penial setae.

This genus helps to bridge over the gap between the Eudrilidae and other earthworms. It possesses, like the remaining genera of Eudrilidae a single median spermathecal sac—probably of mesoblastic origin—opening on to the exterior on the thirteenth segment; but the ovaries are quite free, and hang from the septum dividing segments xii/xiii, entirely unenclosed by any sac. Nevertheless, the median spermathecal sac gives off on either side a much coiled narrow tube, which appears, though MICHAELSEN is not able to be quite certain upon the point, to open into the oviduct. The spermathecal sac lies, at any rate, in *Platydrilus lewaensis*, beneath the nerve-cord. The oviducal funnel opens freely into the thirteenth segment. The usual two pairs of testes are present; these lie in segments x and xi. The spermiducal glands open by a common pore upon segment xvii, just in front of the groove which separates this segment from the one behind. There is no information forthcoming as to the relation of the sperm-ducts to the glands. There are a pair of sacs containing penial setae, which are ornamented. The sperm-sacs are in segments xi and xii. The gizzard is in segment v. There appear to be no calciferous glands of any kind; nor are there any ventral pouches. The nephridia open, as they do in *Nemertodrilus*, in front of the ventral setae.

The genus contains three species; all of these are East African.

(1) Platydrilus callichaetus, MICHAELSEN.

P. callichaetus, MICHAELSEN, JB. Hamb. wiss. Anst., ix, 1891, p. 15.

Definition. *Penial setae with sculpturing, with three points on each side at extremity connected by a wing-like membrane. Hab.—Mbusini, E. Africa.*

This species is only doubtfully included in this genus by MICHAELSEN. The description which MICHAELSEN is able to give is perhaps not quite sufficient to determine the generic position of the worm with certainty. The clitellum is rather longer than that of the only other species (*P. lewaensis*) in which it has been observed. It extends from segment xiv to segment xviii, or possibly xix. The shape of the

penial setae is very unlike that of the penial setae of the two remaining species they are finely denticulate near to the free extremity.

(2) Platydrilus lewaensis, MICHAELSEN.

P. lewaensis, MICHAELSEN, loc. cit., p. 11.

Definition. *Length,* 130 *mm.; breadth,* $2\frac{1}{2}$ *mm.; number of segments,* 204. *Skin unpigmented. Penial setae without sculpturing, sharply pointed at distal extremity. Hab.—Lewa, E. Africa.*

This species is more fully described by MICHAELSEN than are either of the two remaining species. In addition to the points of specific importance mentioned in the above diagnosis, the following are probably of specific value: the setae are strictly paired; the interval between the dorsal setae is about half the circumference of the body; the distance between the pairs of setae of a given segment is about equal, in general two or three times as great as that between the two setae of a pair. In the hinder region of the body the setae are larger than the setae of the anterior segments. The septa which separate segments vi/x are strongly thickened. Contrary to what is found in all other Eudrilidae, except Eudriloides, there are dorsal pores present; these commence between segments vi/vii. The nephridiopores open in front of the lateral setae. No receptaculum was found.

(3) Platydrilus megachaeta, MICHAELSEN.

P. megachaeta, MICHAELSEN, loc. cit., p. 14.

Definition. *Length,* 130 *mm.; breadth,* 2–3 *mm.; number of segments,* 182. *Penial setae without sculpturing, but more slender than in* P. lewaensis, *and without a pointed extremity. Hab.—Makakalla, E. Africa.*

This species differs from the last also in the presence of integumental pigment; the colour is described as being of a clear grey becoming yellowish in front. The setae are strictly paired in the front segments; behind the clitellum they get further apart, and at the same time become longer and thicker. There are no visible dorsal pores. The clitellum extends from the middle of the fourteenth to the middle of the seventeenth segment.

Genus NEMERTODRILUS, MICHAELSEN.

DEFINITION. Setae strictly paired. Clitellum, XIII–XVIII. Male pores upon XVII/XVIII. On XIII a pair of pores leading into interior of that segment.

Spermathecal sacs paired, reaching back to the seventeenth segment, opening in front into the thirteenth segment. No penial setae.

This genus was first investigated by MICHAELSEN (**12**); subsequently I added (**54**) a few particulars to what was known of its structure through MICHAELSEN'S researches.

Nemertodrilus is the only other genus besides *Eudrilus* and *Pareudrilus* in which the genital pores, both male and female, are paired. On this account it is excluded by MICHAELSEN from the subfamily Teleudrilini.

The reproductive organs are evidently somewhat degenerate as compared with those of other Eudrilids. There are two large sacs, which clearly correspond to the spermathecal sacs of other genera; these lie on either side of the gut; they commence at the septum xiii/xiv, and open freely into the cavity of segment xiii. On the other hand they reach back as far as the seventeenth segment. Anteriorly the lumen of these sacs is divided up by trabeculae into numerous chambers, which lodge the developing ova; this region of the sacs appears to represent the receptaculum ovorum of other Eudrilidae; but it is not sharply marked off from the rest of the sac; there is no break between the two regions.

These sacs have been variously interpreted; MICHAELSEN has suggested, on the one hand, that they represent the greater portion of the spermatheca which has got cut off from the duct; this on account of the fact that they were found to contain sperm. 'Perhaps, however,' says Dr. MICHAELSEN, 'it would be more correct to consider that the spermathecae are reduced to the smallest rudiment of the duct, and that the sacs are nothing else than a pair of receptacula ovorum which have also taken on themselves the function of spermathecae.' My own discovery, confirmed by ROSA, that the so-called spermathecae of the Eudrilidae are merely coelomic pouches formed at the expense of the septa, seems to strengthen the first-mentioned view, with which I agree.

The ovaries are in the thirteenth segment affixed, as usual, to the front wall of that segment; the cavity of the segment is greatly reduced so that the ovaries get to be very near the open mouth of the sac already described; there is thus no need for any special investing sac for the ovaries. Into the cavity of this segment also open a pair of pores referred to in the generic definition; the orifices are fringed on the internal side with a number of frayed out cellular processes of the peritoneal epithelium; this arrangement permits of the entry of bodies from without, but hinders the exit of spermatozoa from within. MICHAELSEN pointed out that these paired orifices are the external apertures of the spermathecal sacs; it appeared to me that they might be the rudiments of a second pair of oviducts; I am now convinced that MICHAELSEN'S interpretation is the right one. Now that we know that the spermathecae of the Eudrilidae are coelomic sacs, not comparable, morpho-

logically, to the spermathecae of other Oligochaeta, this view is established on a surer footing.

Nemertodrilus has two pairs of testes occupying the usual segments—viz. x and xi. Opposite to these are the funnels of the sperm-ducts; these are large and much folded, but there is no dilated region of the sperm-duct immediately following them, as there is in other Eudrilids, such as *Eudrilus*. The spermiducal glands are two tubular organs as in other Eudrilidae; their muscular covering is but slight; the tube is lined by the glandular epithelium found in most earthworms; but there is no specialization into a glandular and a non-glandular portion; the two sperm-ducts of each side unite only at their actual orifice into the spermiducal gland, which occurs, as in nearly all Eudrilids, at a little distance from the caecal extremity of the organ.

The integument is entirely without the epidermic sense organs, which are so distinctive a feature of several genera.

Nemertodrilus griseus, MICHAELSEN.

N. griseus, MICHAELSEN, JB. Hamb. wiss. Anst., vii, 1890, p. 17.

Definition. *Length*, 120 *mm.; breadth*, $2\frac{1}{2}$ *mm.; number of segments*, 278. *Nephridia open in front of ventral setae. Anterior septa rather stouter than those which follow. Hab.—Quilimane.*

The appearance of the worm is, according to MICHAELSEN, very like that of a Nemertine, frequently occurring in the German coasts, *Lineus gesnerensis* of O. F. MÜLLER. The colour is 'mouse-grey,' darker on the back than below, often verging towards a greenish olive tint. MICHAELSEN'S specimens were all collected at Quilimane, East Africa.

Genus LIBYODRILUS, BEDDARD.

DEFINITION. **Setae strictly paired. Clitellum complete, (XIV) XV–XVI. Male genital pore between segments XVII/XVIII. A single median spermathecal sac, communicating with the exterior on segment XIII, forming a ring round the oesophagus, and again round the nerve-chord. Penial setae present.**

This genus was described by myself a year or two ago, from specimens received from Lagos, West Africa; it contains, at present, but one species, *L. violaceus*.

The first intersegmental septum separates segments iv/v; the septa which lie

behind the first are thickened, and formed of two distinct layers of fibres; the last of the thickened septa separates segments xi/xii; the next septum, however, although not so thick as those which precede it, is thicker than those which follow.

Another character, which at present distinguishes the present genus from any other, is the formation of separate chambers for the setae. A membrane shuts off the area occupied by the septa from the rest of the body-cavity; this condition is only paralleled among the Capitellidae.

The alimentary canal of *Libyodrilus* differs from that of other Eudrilidae in having no glandular appendages to the oesophagus. There are three gizzards, which lie in segments xxiii–xxv, one gizzard to each segment. The intestine has a typhlosole; this is of rather a peculiar form; from its commencement to about the thirty-seventh segment three folds can be seen on dissection; the middle one is about three times the diameter of the two lateral folds; after the thirty-seventh segment the two lateral folds disappear.

The testes are two pairs in the eleventh and twelfth segments respectively; they are quite unenclosed by the sperm-sacs. The sperm-sacs are in the eleventh and twelfth segments. Each sac is independent of its fellow; the sperm-ducts are also unenclosed by the sperm-sacs; nor is there any dilatation of the duct near to the funnel, such as is met with, for example, in the genus *Eudrilus*. The funnels of the sperm-ducts, moreover, face forwards, as in the majority of Oligochaeta; they do not depend from the anterior wall of their segments (the tenth and eleventh) as in many Eudrilidae. The spermiducal glands have the tubular form which is met with in all the Eudrilidae. They are particularly short, and open by a common aperture; the spermiducal glands have a thick muscular wall; with each is connected a sac containing a single short penial seta; this seta is quite unornamented; the sperm-ducts retain their distinctness up to the point of opening into the glands; they appear to open into the gland close to its external orifice; but, as a matter of fact, they pass up within the thickness of the muscular layer of the organ, and actually open into its lumen quite at the summit; the lining membrane of the spermiducal gland is greatly folded.

A large sac lies upon the dorsal surface of the oesophagus[1], extending from the anterior boundary of segment xiii to the posterior extremity of segment xviii. This sac gives off on either side three diverticula; anteriorly the sac divides so as to embrace the oesophagus, and again to surround the nerve-cord. This sac contains spermatozoa, and is the physiological equivalent of the spermathecae of other earth-

[1] On p. 134 will be found a more detailed description of the structure and development of this sac.

worms. It is, however, as I have shown, developed from the septa, and is therefore to be regarded as a coelomic pouch comparable to the sperm-sacs of this and other Oligochaeta. The ovaries are not visible in adult worms. They are obvious enough in young specimens, and occupy the usual position, attached to the front wall of segment xiii. They would be, were they persistent in the adult worm, enclosed within the sac already described. The egg-sac is closely adherent to the anterior of the three diverticula of the spermathecal sac; its lumen, however, does not communicate with that of the spermathecal sac.

Libyodrilus violaceus, Beddard.

L. violaceus, Beddard, Q. J. M. S., vol. xxxii, 1891, p. 539.

Definition. *Length,* 155 *mm.; diameter,* 5 *mm.; number of segments,* 200. *Colour, dull purplish brown. Clitellum, XIV–XVI. Hab.—Lagos.*

Genus STUHLMANNIA, Michaelsen.

Definition. Setae strictly paired. A median penial process. Spermathecal orifice in XIII. Male pores XVII/XVIII. Ovaries enclosed in sacs. Penial setae present.

This genus, like so many others of the Eudrilidae, has only one species. It is, therefore, hard to distinguish generic from specific characters. The most marked external character of the genus is the median penis, whose position is variable and presence even inconstant. I have described the minute structure of this organ above (p. 125).

The clitellum extends from xiv–xvii (sometimes from xiv–xvii only).

The female reproductive organs are for this genus, as for most Eudrilidae, peculiar and characteristic. The external pore opens into a large sac, whose walls are at first very muscular and form a bursa copulatrix; from this arise two slender tubes which pass round the first mentioned sac and the gut, and then unite with each other to form a small median backwardly directed sac. From the ring which surrounds the gut leads on each side a delicate tube, which presently swells out to form an egg-sac, from which the oviduct leads to the external aperture on the fourteenth segment.

The position of the ovaries is a matter of doubt, but it seems likely that they are concealed somewhere or other within the system of sacs already described. It is remarkable that in a large number of specimens which I dissected, the egg-sacs of the right side of the body only were fully developed, those of the left side being rudimentary.

There are two pair of testes and funnels; the latter do not lead into a dilated part of the sperm-duct as in many Eudrilids. The spermiducal glands open by a common orifice through which protrude a pair of penial setae. Connected with the penis is a muscular sac opening on to one side of it, and terminating blindly in the body-cavity.

I have already dealt with the peculiar calciferous glands of this species. The gizzard lies in v; septa v/xii are thickened.

Stuhlmannia variabilis, Michaelsen.

S. variabilis, Michaelsen, JB. Hamb. wiss. Anst., vii, 1890, p. 24.

Definition. *Length,* 125 *mm.; diameter,* 2 *mm.; number of segments,* 175. *Setae show traces of ornamentation. Penial setae grooved at free extremity with serrated margins. Hab.—Korogwe, Kihengo, Mombasa, Zanzibar.*

This species was at first (**12**) briefly, and then more fully (**6**) characterized by Michaelsen with illustrations. I have myself examined a large number of specimens, both living and preserved. The living worms are extraordinarily thin and apparently tough; during life their length is very considerably greater than after preservation. The above dimensions are considerably in excess of those which I noted in preserved examples, but Michaelsen states that he had sexual specimens not half the length. The setae often showed a yellowish-brown coloration at the extremity and faint transverse ridges. I received this species from bogs on the African coast, where they were collected for me by Mr. Finn.

Sub-Family Eudrilini.

Definition. **Integumental sense organs present. Calciferous glands paired and unpaired of the usual structure. No integumental nephridial network; sperm-ducts with dilatation immediately following funnel.**

Genus EUDRILUS, Perrier.

Definition. **Setae paired. Male pores paired on XVII. Spermathecal pores paired on XIV. Two median calciferous pouches in X, XI. Paired calciferous glands in XII. Oviducts open into the spermathecal sac of their own side, the latter has an appendix of a glandular nature (?). Each spermiducal gland is divided by a longitudinal septum into two halves. No penial setae.**

This is one of the few genera of extra European Terricolae which has quite a long history. It is one of the types described by PERRIER in his classical paper upon the classification of the Oligochaeta (**3**). PERRIER there described three species, the validity of which will be considered later. The next contribution to the structure of the genus was by myself, and dealt with the peculiar features of the female reproductive organs (**14**). In two subsequent papers I described two 'species' of *Eudrilus*, the one from New Caledonia (**4**), the other from British Guiana (**62**). A little later HORST (**2**) made some remarks upon specimens of *Eudrilus* from New Caledonia and Surinam. The two most recent contributions to the structure of this genus are a paper by HORST (**8**) upon the anatomy of a species of the genus from Liberia, and a description by MICHAELSEN (**10**) of two species, really distinct, from the coast of West Africa.

The present genus is remarkable for its extremely wide distribution. There are very few terrestrial Oligochaeta excepting those belonging to the genera *Lumbricus* and *Allolobophora*, which are more widely distributed; but there are not many quarters of the globe which have not been shown to harbour the genus *Eudrilus*. It is found in the West Indies, in South America, in West Africa and St. Helena, in Ceylon, in New Caledonia, and in New Zealand. A more detailed account of its distribution will be found under the description of the species. Of species the following have been described:—

E. lacazii, PERRIER, Martinique.
E. peregrinus, PERRIER, Rio Janeiro.
E. decipiens, PERRIER, West Indies.
E. boyeri, BEDDARD, New Caledonia.
E. sylvicola, BEDDARD, British Guiana.
E. jullieni, HORST, Liberia.
E. pallidus, MICHAELSEN, Accra, West Africa.
E. buttneri, MICHAELSEN, Togo, West Africa.
E. roseus, MICHAELSEN, Venezuela.
E. erudiens, UDE, Bermudas.

(1) **Eudrilus eugeniae** (KINBERG).

E. Lacazii, PERRIER, Nouv. Arch. Mus., 1872, p. 75.
E. peregrinus, PERRIER, ibid., p. 77.
E. decipiens, PERRIER, ibid., p. 78.
E. boyeri, BEDDARD, P. Z. S., 1886, p. 302.

E. sylvicola, BEDDARD, P. Z. S., 1887, p. 372.

E. jullieni, HORST, Mém. Soc. Zool. Fr. 1890, p. 223.

E. roseus, MICHAELSEN, Arch. f. Nat., 1892, p. 224.

Lumbricus eugeniae, KINBERG, Öfv. Svensk. Akad., 1866, p. 98.

Definition. *Length*, 140 *mm.; breadth*, 5·5 *mm.; number of segments*, 180. *Skin deeply pigmented. Bursa copulatrix with glandular appendices. Spermathecal sacs with glandular appendix. Hab.—West Indies; British Guiana; New Caledonia; West Africa; Ceylon; New Zealand; St. Helena.*

This species has been investigated by a number of naturalists, whose names are given in the above synonymy. I include in one species not only the three species described by PERRIER, but also the two species described by myself and the supposed new forms described by HORST and MICHAELSEN. The accounts given by these various writers do not appear to me to give any characters which serve to distinguish species. PERRIER'S account was defective owing to the poor condition of the material which he had to work with. The characteristic feature of this species as compared with the other is the presence of peculiar appendices to the bursa copulatrix which are shown in the woodcut on page 112; the two appendices are sometimes independent and sometimes fused together at the end to form a single horseshoe-shaped appendix. The glandular appendix of the spermathecal sac in this species is subdivided by trabeculae into a number of compartments; it opens into the duct of the sac at a point exactly opposite to the entrance of the oviduct. The spermiducal gland is divided by a median septum into two chambers, into one of which only open the sperm-ducts. I found in one specimen (examined for this purpose) that the last heart was in xii and the first pair of nephridia in iv.

Through the kindness of Prof. LOVEN I have been able to examine for myself KINBERG'S '*Lumbricus eugeniae*,' which I cannot distinguish from the other 'species' enumerated in the above list of synonyms. The name *Eugeniae* must therefore, I think, stand for the species. The only discoverable ground for regarding my *E. sylvicola* as distinct, is its smaller size.

(2) Eudrilus pallidus, MICHAELSEN.

E. pallidus, MICHAELSEN, Arch. f. Nat., 1891, p. 216.

Definition. *Length*, 160 *mm.; breadth*, 5–6 *mm.; number of segments*, 196. *Skin without pigment. Clitellum, XIII–XVIII. Bursa copulatrix without appendices. Spermathecal sac has two diverticula at base as well as the appendix found in* E. decipiens. *Hab.—Accra, W. Africa.*

This species is quite distinct from the last. It can apparently be distinguished by the fact that the skin does not possess that dark violet colour which is so characteristic of the various species of the genus that I unite here into the species *E. eugeniae*. Only a single example was investigated by MICHAELSEN. It seems in nearly all its structural characters to agree with the last species; the only point in addition to those mentioned in the above diagnosis of the species in which *E. pallidus* differs from *E. eugeniae* is in the fact that the two sperm-ducts of one side unite to form a single tube before they enter the spermiducal gland. The bursa copulatrix, although present as in *E. eugeniae*, is apparently less developed than in that species. It is described by MICHAELSEN as the slightest rounded elevation of the body-wall. As the peculiar appendices of this bursa—which I have elsewhere compared with sacs for the penial setae—are absent in the present species, it seems that the terminal copulatory apparatus is in a condition of degeneration.

(3) Eudrilus buttneri, MICHAELSEN.

E. Büttneri, MICHAELSEN, Arch. f. Nat., 1892, p. 256.

Definition. *Length*, 110 *mm.; breadth*, 5 *mm.; number of segments*, 145. *Colour purple above. Bursa copulatrix without appendices. Female genitalia as in* E. pallidus. *Hab.—Togo, Bismarckburg, W. Africa.*

This species only differs from *E. pallidus* in the fact that the skin is pigmented; in all other particulars it appears to agree with that species, unless the position of the male pores be really different; in *E. pallidus* these pores are stated to be on the seventeenth segment in line with the ventral setae, in *E. buttneri* on the border line of segments xvii/xviii, a little above the line of the ventral setae.

(4) Eudrilus erudiens, UDE.

E. erudiens, UDE, Z. wiss. Zool., 1892, p. 71.

Definition. *Length*, 220 *mm.*[1]*; diameter*, 5 *mm.; number of segments*, 180. *Colour pale yellow to brown. Bursa copulatrix with* Y*-shaped appendage. Female genitalia as usual. Hab.—Bermudas.*

This species appears to differ from *E. eugeniae* by its colour only.

[1] These measurements cannot be regarded as very accurate; the worms were much softened.

Genus EMINOSCOLEX, MICHAELSEN.

DEFINITION. Lateral setae more closely paired than ventral. Male pores between XVI/XVII. Calciferous pouches in IX–XI, calciferous glands in XIII. Spermathecal apparatus paired; true spermatheca present surrounded by spermathecal sac at end; ovaries enclosed. No penial setae.

This genus agrees with *Eudrilus* in having completely paired genitalia. The female organs have been more completely described in *Eminoscolex toreutus* than in *E. viridescens*. The following is a more detailed account of their structure in the former species. The ovaries are attached to septum xii/xiii. Each is enclosed in a sac which is continuous with a large spermathecal sac extending backwards; near to where the ovarial sac opens into the latter arises, on the one hand, a stalked egg-sac, and on the other, the oviduct. Between segments xii/xiii opens on to the exterior a sac, the posterior end of which appears to be enclosed by, though it does not open into, the spermathecal sac. This is not, however, quite certain; the present genus may resemble in this particular *Eudriloides* or *Hyperiodrilus*. In any case the genus is more closely allied to the latter, since it has the dilated vesicles upon the sperm-ducts immediately after their origin from the funnels, and has the unpaired calciferous glands so characteristic of the present subfamily of the Eudrilidae.

(1) Eminoscolex toreutus, MICHAELSEN.

E. toreutus, MICHAELSEN, Thierwelt Ost-Afrik., Regenw., p. 8.

Definition. *Length*, 85 *mm.; number of segments*, 140. *Clitellum, XIII–XVIII* (?). *Male pores on two papillae. Nephridia commence in IV. Hab.—Runssoro, and Kirima, Albert Edward Lake, E. Africa.*

(2) Eminoscolex viridescens, MICHAELSEN.

E. viridescens, MICHAELSEN, loc. cit., p. 9.

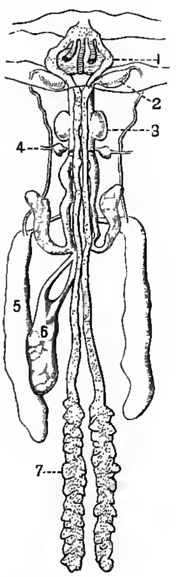
Definition. *Length*, 60 *mm.; number of segments*, 77. *Clitellum, XIV–XVIII. Spermatheca present as in last species, but rudimentary. Hab.—Runssoro.*

Genus POLYTOREUTUS, MICHAELSEN.

DEFINITION. Setae paired, those of ventral pairs further apart than those of dorsal. Clitellum complete, XIII–XVIII. Male pore on XVII/XVIII. Calciferous glands in XIII, ventral pouches in IX, X, XI. On XIX aperture of spermathecal sac, which is large and complicated, on XVIII/XIX. Ovaries enclosed by an extension forwards of the spermathecal sac. No penial setae.

The genus is remarkable in the family for the fact that the spermathecal pore is placed behind the male pore; in all the other genera it lies in front of the male pore.

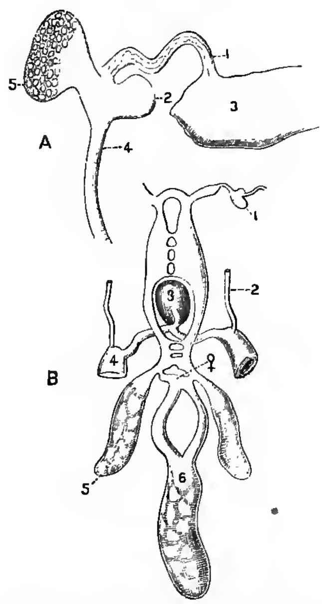
Fig. 49.



GENERATIVE ORGANS OF POLYTOREUTUS MAGILENSIS.

1, 7. Sperm-sacs. 2. Sperm-ducts. 3. Calciferous glands. 4. Oviducts. 5. Spermiducal glands. 6. Spermathecal sac.

Fig. 50.



FEMALE GENERATIVE ORGANS OF THE SAME MORE HIGHLY MAGNIFIED.

Fig. A. 1. Duct leading from egg-sac (5) to spermathecal sac (3). 2. Ovarian sac. 4. Oviduct.

Fig. B. 1 egg-sac. 2. sperm-duct. 3. Bursa copulatrix. 4. Spermiducal gland. 5, 6. Spermathecal sac. ♀ External opening of same.

The sac into which the aperture of segment xix opens is unusually complicated; it is evidently a coelomic pouch as in other Eudrilids. Anteriorly the ovaries are each enclosed in a small sac; this is appended to the septum between segments xii/xiii; this ovarian sac communicates by a narrow duct with the spermathecal sac; the spermathecal sac shows traces of being double. In *P. coeruleus*, *P. violaceus*, *P. kilindinensis*, and *P. elongatus*, the two tubes fuse altogether, but in *P. magilensis* (woodcut 50, fig. B) they remain separate, for the most part being connected by transverse tubes of smaller calibre forming a ladder-like arrangement. In *P. silvestris* and its immediate allies the two sacs are separate posteriorly only.

Near to the external opening in *P. coeruleus* four long diverticula arise from the spermathecal sac; the two posterior of these are the longest; in *P. magilensis* these two posterior diverticula after a very short course unite to form one stout tube; in *P. violaceus* there are a series of lateral diverticula, a pair

to each segment. All these various sacs, which together constitute the sperm-receiving apparatus, communicate with the exterior by a short very thick-walled Bursa. The whole system of cavities is filled with spermatozoa, presumably received from another individual; in *P. magilensis* and *P. violaceus*, at any rate, these spermatozoa are in the form of 'sperm-ropes,' which are much like those of the Tubificidae. The mouth of the oviduct just by its division into the two branches which go respectively to the egg-sac and to the ovarian sac, was invariably plugged with bundles of spermatozoa, not in the form of sperm-ropes. This appears to indicate that fertilization takes place at this point; but whether the spermatozoa have worked their way up the oviduct or have come down from the spermathecal sac is a question that requires further study before it can be decided.

Polytoreutus has but one pair of testes; these, as is usually but not invariably the case when only one pair is developed, lie in the eleventh segment. The sperm-sacs have a very unusual form—unusual, that is to say, for this family; they resemble those of many Geoscolicidae in their extraordinary length. In *P. magilensis* the sperm-sacs reach from the eleventh to the sixtieth segment; the anterior part of the sacs generally consists of a narrow tube lying freely in the body cavity—not suspended in any way to neighbouring viscera; from the thirtieth segment onwards the sperm-sacs are thicker walled and sacculate, being constricted at the septa.

The sperm-ducts are as in many Eudrilidae widened, just before they open into the coelom by the funnel.

The spermiducal glands are very long; in *P. magilensis* they extend through about sixteen segments; in *P. coeruleus* MICHAELSEN figures and describes a series of regular short paired diverticula; in *P. magilensis* they are sacculate. The five species of the genus can be distinguished by the shape of the spermathecal sac.

(1) Polytoreutus coeruleus, MICHAELSEN.

P. coeruleus, MICHAELSEN, JB. Hamb. wiss. Anst., vii, 1890, p. 24.

Definition. *Length,* 140 *mm.; breadth,* 4 *mm.; number of segments,* 200. *Clitellum, XIII–XVIII. Spermathecal sac with two pairs of lateral diverticula, one in front of, and one behind the male pore. Hab.—Makakalla, Korogwe, Mhonda, E. Africa.*

This species (described by MICHAELSEN in two papers **6, 12**) appears to occur in four varieties, distinguished by the position of the male pores and that of certain papillae. These differences are as follows:—

Forma **Makakallensis**	First papilla upon xvii; two others upon xix, xx; in every case in the middle line of segment.
Forma **Korogweensis**	First papilla as in last variety; second and third upon xviii/xix and xix.
Forma **Affinis** . . .	Like the last, but with the addition of a papilla upon xx.
Forma **Mhondaensis** .	Male pore xvi/xvii, first papilla upon xvii, another upon xix.

In all except the last variety the male pore is upon the middle or end of the seventeenth segment. Septa vi/vii–xi/xii are thickened, the first much less than the rest. The sperm-sacs are not described in much detail; it is only remarked that the sperm-sacs arising from the single sperm-reservoir pass back to the twentieth segment, sometimes even further. The spermiducal glands extend back as far as to the forty-ninth segment; each is furnished with a double series of short diverticula. The two diverging anterior extremities of the spermathecal sac terminate in a spherical ovarian sac, which is attached to the septum xii/xiii by muscular strands. The oviduct, immediately after receiving the branches from egg-sac and ovarian sac, is provided with several caeca which lodge bundles of spermatozoa.

(2) Polytoreutus magilensis, Beddard.

P. magilensis, Beddard, Q. J. M. S., vol. xxxiv, 1892, p. 243.

Definition. *Length, 360 mm.; diameter, 8 mm.; number of segments, 270. Clitellum, XIII–XVII; male pore and spermathecal pore upon a shield-shaped, raised area; spermathecal sac partly double, complicated in structure with two pairs of diverticula, last pair fused for greater part of their length. Hab.—Magila, E. Africa.*

This, the largest species of the genus, is of a purplish colour dorsally. Septa v/xi are thickened. The salient points in its anatomy have been referred to under the description of the genus. The complicated reproductive organs are shown on page 607.

(3) Polytoreutus violaceus, Beddard.

P. violaceus, Beddard, Q. J. M. S., vol. xxxvi, 1894, p. 230.

Definition. *Length, 83 mm.; breadth, 4 mm.; number of segments, 190. Clitellum, XIV–XVII (XVIII). A median papilla upon XXII–XXIII. Spermathecal sac with eight pairs of diverticula, a pair to each segment. Hab.—Mombasa, E. Africa.*

Even in alcohol this species showed a dark purplish colouration, the under surface being yellowish; the clitellum was also yellow. The setae are nowhere absent except the ventralmost setae on each side of the thirteenth segment; I found setae upon the

clitellum which MICHAELSEN did not find in his species. The single genital papilla is oval in outline with raised margins; it extends a little way to the outside of the ventralmost setae.

The shape of the spermathecal pouch is highly characteristic of the species: the most anterior pair of diverticula in which the sac terminates do not, as in *P. coeruleus*, end in an ovarian sac; in the present species there are a pair of minute sacs, one to each of the anterior processes of the spermathecal sac, which are attached a little way behind the actual termination of the sac; these seem to be the equivalents of the ovarian sac of *P. coeruleus*. The sperm-sacs originate as two very fine tubes, which, in the thirtieth segment, become much wider; the wider part of the sperm-sacs is about ten segments in length.

(4) Polytoreutus finni, BEDDARD.

P. Finni, BEDDARD, loc. cit., p. 241.

Definition. *Length*, 183 *mm.; breadth (at clitellum)*, 3 *mm.; number of segments*, 500. *Clitellum, XIII–XVIII. Spermathecal sac with only one pair of diverticula, in XIII. Hab.—Kilindini, E. Africa.*

This species is also very distinct; its most obvious external character is its extraordinary length and number of segments; on the ventral surface the two genital apertures occupy nearly the whole of the body, and appear to be unusually large; between the two pores is an area which differs in appearance from the rest of the clitellum; the orifices are marked by a series of radiately arranged furrows. With regard to internal characters, there are other distinguishing marks of the species besides those mentioned in the above definition. The paired calciferous glands seem to be situated a segment or two further back than is the case with other species; their shape too is peculiar; each is curled like a ram's horn. The sperm-sacs are slender tubes, like the sperm-sacs of other species, for the first few segments of their course; here and there, one, at any rate, of the two sacs exhibited varicosities which lodge the sperm; it may be that the sperm-sacs of the single individual examined by me were immature.

(5) Polytoreutus kilindinensis, BEDDARD.

P. kilindinensis, BEDDARD, loc. cit. p. 236.

Definition. *Length*, 120 *mm.; breadth*, 5 *mm.; number of segments*, 220. *Clitellum, XIV–XVIII. A median papilla extending over segments XVIII–XXI. Spermiducal sac as in* P. elongatus. *Hab.—Kilindini, E. Africa.*

This species is also a very distinct form which cannot be confused with any other species. Its colour appears to be not unlike that of *P. violaceus*, but paler. The setae seem to be, to some extent, defective upon the segments which bear the genital pores. The single median papilla lying behind the clitellum projects somewhat; it has no definite boundary like that which marks the papilla of *P. violaceus*. The male pore is placed a little further back than this aperture in other species; it opens between segments xvii/xviii; the female pore is on the eighteenth. There are six specially thickened septa, the first of which divides segments v/vi. The sperm-sacs differ from those of other species in that the anterior slender region of the sac is confined to the eleventh and twelfth segments; they reach to about the twenty-seventh. In an immature example of this species I found the sperm-sac to show the same characters as those which have been described; this, of course, increases the probability of that description being of a normal worm; but in this specimen the two sacs were fused at their posterior extremity; this individual was furthermore remarkable for the fact that the dorsal vessel was double in segments viii–xii. It may, therefore, be conceivably a distinct species.

(6) **Polytoreutus gregorianus** (NEW SPECIES).

Definition. *Length*, 212 *mm.; diameter*, 7 *mm.; number of segments*, 440. *Clitellum, XIII–XVIII. Spermathecal pore XVII/XVIII. Male pore, XIX. On fifteen segments following male pore a ventral median glandular thickening. Spermathecal sac with two long diverticula at anterior end and two shorter ones at posterior end. Hab.—Giriama, near Fuladoya, E. Africa.*

Of this species there is a single example in the British Museum, which was collected by Dr. J. W. Gregory at the above-mentioned locality. The ventral glandular thickening on segments xx–xxxv, resembles that of *Polytoreutus*. The glandular patches, which are of a deeper brown than the surrounding integument, occupy not quite all the space between the two outermost of the ventral seta couples; they are sharply divided by the intersegmental furrows. As to internal characters the species is distinguished from others by the form of the spermathecal sac. The median part of the sac is wide, but shows no external traces of division into two. Anteriorly it divides in the usual way into two large lateral diverticula which almost meet on the dorsal surface of the intestine. The ovarian canal springs from near the root of this diverticulum; the ovarian sac, the receptaculum ovorum and the oviduct are quite as in other species. Close to the external orifice of the spermathecal sac are two smaller diverticula, one on each side.

The spermiducal glands are long and thick with an irregular sacculation towards the blind end. The distal end of each gland is slightly thicker and sharply marked off from the rest; it narrows, however, before opening into the median bursa. The sperm-sacs are long (28 mm.) and occupy about twenty segments; they are fused at the distal extremity. The anterior third or rather more of each sac is, as in other species, a slender tube showing no increase of diameter between the septa.

The last thick septum bounds segment xi posteriorly. The dorsal vessel suddenly diminishes in calibre in the fourteenth segment; it is double in segments viii, ix and xii, xiii, and possibly some anterior to the eighth.

(7) **Polytoreutus usindjaensis,** Michaelsen.

P. usindjaensis, Michaelsen, Thierwelt Ost-Afrik., Regenw., p. 14.

Definition. *Length,* 200 *mm.; number of segments,* 199. *Clitellum, XIV–XVII. Spermathecal sac divides at first into two, each with a large diverticulum, reuniting afterwards. Hab.—Usindja, Bukoba, Mtagata, Amranda, E. Africa.*

The fact that the spermathecal sac is double at first distinguishes this species from all those that have been as yet described; but it agrees in this with the two following.

(8) **Polytoreutus kirimaensis,** Michaelsen.

P. kirimaensis, Michaelsen, loc. cit., p. 16.

Definition. *Length,* 140 *mm.; number of segments,* 236. *Clitellum, XIV–XVII. Spermathecal sac as in last species. A pair of large muscular sacs open into bursa copulatrix in common with spermiducal glands. Hab.—Kirima, Lake Albert Edward, E. Africa.*

This species is in many respects like the last; the most noteworthy difference being the presence of the large lateral sacs which open in common with the spermiducal glands. These structures, which also occur in the next species, are possibly to be compared with the muscular sac found in *Stuhlmannia.* The sperm-sacs on the present species extend back as far as the forty-fifth segment; up to the thirty-sixth segment they are thin and delicate.

(9) **Polytoreutus silvestris,** Michaelsen.

P. silvestris, Michaelsen, loc. cit., p. 18.

Definition. *Length,* 300 *mm.; number of segments,* 300. *Clitellum, XIII–XVII. Spermathecal sac as in last species, but diverticula of much greater length, and sac double from the very first. A pair of large muscular sacs open into bursa copulatrix. Hab.—Runssoro Forest.*

This species evidently comes near to the last. It has the same character, only rather more pronounced. But there are also differences. The duct of the spermiducal glands, instead of arising from one end arises in the middle: and the spermathecal sac arises as two tubes from the terminal bursa, instead of being at first single and then dividing as in the last species. The sperm-sacs extend back as far as the sixtieth segment, being wide from the thirty-fourth. Both the bursa and the two copulatory glands on the male apparatus can be protruded.

Genus **PREUSSIA**, MICHAELSEN.

DEFINITION. **Lateral setae strictly paired; ventral setae more separated. Male pore on XVII or XVII/XVIII. Spermathecal pore on XV. Gizzard small or rudimentary; calciferous glands and median calciferous pouches present. Median spermathecal sac with two diverticula, into which open oviducal funnels. Ovaries in a large sac. Penial setae.**

The female organs of reproduction are different in detail from those of any other Eudrilid; they are only known in the species *Preussia siphonochaeta;* the median pore upon the fifteenth segment leads into a moderately long spermathecal sac, which extends back as far as to the nineteenth segment anteriorly—that is near to its external pore—this sac is furnished with two thin-walled sacs; into these open the oviducts. About half way between this internal aperture and the external pore the oviduct of each side has a receptaculum; the oviduct makes a sharp bend between the internal opening and the egg-sac, reaching back as far as the middle of the fifteenth segment. If the body identified as the egg-sac by MICHAELSEN is really such, the entire stretch of 'oviduct' between this and the sac into which it finally opens must be a long drawn-out funnel. The ovaries themselves lie in the usual position; they appear to be enclosed in a common sac, the nature of whose communication with the rest of the apparatus is a matter of uncertainty.

(1) **Preussia siphonochaeta**, MICHAELSEN.

P. siphonochaeta, MICHAELSEN, JB. Hamb. wiss. Anst., viii, 1891, p. 23.

Definition. *Length,* 105 *mm.; breadth,* $4\frac{1}{2}$ *mm.; number of segments,* 128. *Clitellum, XIII–XVIII. Gizzard rudimentary in VI. Penial setae smooth. Hab.—W. Africa.*

The prostomium of this species is prolonged on to the buccal segment. MICHAELSEN has not mentioned the presence of ventral calciferous pouches, which exist in the other species of the genus. The intestine has a typhlosole.

(2) Preussia lundaensis, Michaelsen.

P. (?) lundaensis, Michaelsen, Arch. f. Nat., 1891, p. 219.

Definition. *Length,* 90 *mm.; breadth,* $4\frac{1}{2}$ *mm.; number of segments,* 193. *No gizzard. Penial setae armed at extremity with fine hooks. Hab.—Lunda, W. Africa.*

As Michaelsen only examined a single immature example of this species, its systematic position is a matter of doubt; it agrees with the other species in the arrangement of the setae, in the position of the spermathecal orifice and in the hollow penial setae, which are, however, in the present species provided with hooklets at the free end, disposed at right angles to the shaft of the seta.

Genus PARADRILUS, Michaelsen.

Definition. Setae paired, ventral being a little further apart than dorsal. Clitellum complete, XIII–XVIII. Calciferous glands in XII; ventral pouches. Male pore on XVIII. Spermathecal orifice on XII, the spermathecal sac consists of median pouch opening on to XII/XIII; with this are connected two lateral sacs opening above on to gut, a pair of glandular diverticula exist, one to each of ovarian ducts. Sperm-ducts open into dilated chambers before funnels.

In spite of the careful work which has been done by both Michaelsen and Rosa upon this genus, a good deal yet remains to be made out before the systematic position of the genus can be decided. It is not known whether the integumental sense organs are present, and it is not certain whether the ventral median calciferous pouches exist as in the allied genus *Polytoreutus;* I say 'allied' because the arrangement of the setae recalls that genus, and, as has already been pointed out, a comparison can be made between the, at first sight, diverse spermathecal sacs of both. Another matter that requires clearing up is the structure of the female reproductive organs in the various species; the figures which Michaelsen gives of these organs in *P. ruber*, and in *P. purpureus* show some differences from *P. rosae*. In both of the former species Michaelsen has figured the sac as ending behind in two branches which open into the gut; on the contrary, in *P. rosae*, Rosa has figured and described the lateral diverticula of the sac as arising near to its external pore, and running close to it as far as the point where they diverge to open into the oesophagus; nor is the nature of the glandular appendix of the ampulla upon the ovarian duct quite understood; as to the opening into the gut this was first clearly proved by Rosa, though Michaelsen figured these tubes with open ends; he thought, however, that they met above the gut as in *Stuhlmannia*.

(1) Paradrilus rosae, MICHAELSEN.

P. Rosae, MICHAELSEN, JB. Hamb. wiss. Anst., viii, 1891, p. 26.

Definition. *Length*, 370 *mm.; breadth*, 10 *mm.; number of segments*, 350. *Penial setae furnished at extremity with two wing-like processes, on which are fine granulations. Hab.—Fernando Po, Barombi, W. Africa.*

This species has been carefully studied by both MICHAELSEN and ROSA (**35**); it is possible that there are other characters than those mentioned in the above definition which distinguish it from the other species. Neither ROSA nor MICHAELSEN say anything about the ventral unpaired calciferous pouches described by the latter in *P. purpureus.* Septa iv/xiii are thickened (ROSA says iv/vi and viii/xii).

(2) Paradrilus ruber, MICHAELSEN.

P. ruber, MICHAELSEN, Arch. f. Nat., 1891, p. 220.

Definition. *Length*, 360 *mm.; breadth*, 10 *mm.; number of segments*, 286 (*about*). *Penial setae flattened at extremity, and furnished with two rows of longish spines. Hab.—Togo Land, W. Africa.*

There are some other small differences between this species and the last; the prostomium is not continued on to the buccal segment, but it is triangular behind and fits into a depression on that segment. In front and behind the male pore is a crescentic furrow. MICHAELSEN speaks of an aperture on the fifteenth segment, which, however, did not show any connexion with any organ in the interior of the body. Septa x/xii are much thickened.

(3) Paradrilus purpureus, MICHAELSEN.

P. purpureus, MICHAELSEN, loc. cit., p. 222.

Definition. *Length*, 220 *mm.; breadth*, 7 *mm.; number of segments*, 178. *Penial setae absent. Hab.—Barombi, W. Africa.*

The most obvious distinguishing mark of this species is the total absence of penial setae. The prostomium is as in *P. rosae.* The septa vii/xii are specially thickened.

Genus HYPERIODRILUS, BEDDARD.

DEFINITION. Setae paired, those of ventral pairs further apart than dorsal. Clitellum, XIV–XVII. Male pore between XVII/XVIII; two penes on segment in front or further forward (position variable), connected by grooves with male pore. Spermathecal pore on XIII. Gizzards in XVIII–XXIII; calciferous glands in XII; pouches in IX, X, XI. Testes in XI (and XII?). Sperm-sacs in XI, XII. Funnels lie in XI, XII. No penial setae. Spermatheca small, enclosed within large spermathecal sac, which surrounds gut, and communicates with sacs containing ovaries.

This genus has, at present, been studied by myself only; it contains but one species. Of the external characters, the penes appear to be very characteristic; it is also a remarkable fact that they vary in position as in *Alvania* and *Stuhlmannia,* the only other genera in which a penis or penes are present. I found three variations; in one specimen the two papillae, which I call penes, were symmetrical, and lay upon the middle of the seventeenth segment, not very far in front of the male pore; in a second one the penis, the left-hand one, was on the border-line of segments xvi/xvii, and was larger than the right-hand penis; the latter lay at about the middle of the seventeenth segment; in a third the two penes were but little prominent, and were very closely approximated to each other and to the male-pore, forming altogether a triangular swelling; in every case the two papillae were connected by a groove with the male pore; the male pore usually did not present the appearance of a pore, owing to the fact that the distal end of the bursa was slightly protruded.

The male generative organs present some unusual features; there appear to be only a single pair of testes; these are unenclosed in any sperm-sac, and are attached to the sperm-duct as it issues from the tenth segment; there may be a second pair; but, if so, it seems likely that they will be found in a corresponding position in the twelfth segment. The fact is that here, as in *Teleudrilus* and a few other forms, the sperm-ducts perforate the septum, whence depend the funnels, twice. The sperm-duct, passing forwards, makes its way through one of the septa in question; it then dilates into a wide oval sac, as in *Teleudrilus*, &c.; bending back, it again perforates the septum, and opens into the interior of the segment by the funnel, or, rather, into the sperm-sac which is attached to the anterior wall of the eleventh and twelfth segments. The abnormal position of the funnels may perhaps be accounted for by the pulling back of the end of the sperm-duct during the growth of the sperm-sac; in any case, the sperm-sacs are, no doubt as in other worms, developed

from the septa to which they are appended, and their lumen is really part of the lumen of the segment in front of that in which they lie; hence, the position of the funnels is not perhaps so anomalous as it might at first appear. The spermiducal glands have a distinctly separated muscular duct; the glandular part of the organ has not a thick muscular sheath. The female reproductive organs are very complex; the diagram on page 577 may help to make matters clear; on the dorsal side of the body, and lying above the gut, is a large sac which bifurcates anteriorly, and passes below the gut to reunite on the ventral side of this; this sac appears to open on to the exterior by the pore on the thirteenth segment; but this is not really what happens; in sections the external pore is seen to lead into a small globular sac from which arises a narrower sac, dilating somewhat at its extremity; this is the true spermatheca, and it lies within the left branch of the large sac surrounding the gut, without communicating with it in any way that I have been able to discover; the ovaries, lying in the usual position for these organs to occupy, are enclosed each in a sac; from each sac arises a narrowish tube which puts into communication with the corresponding arm of the peri-oesophageal sac; the two ovarian sacs also communicate by another narrow tube which passes across the nerve-chord; also attached to either arm of the peri-oesophageal sac, but apparently not communicating with its lumen, is an egg-sac; it lies, as usual, on the posterior face of the septum separating segments xiii/xiv.

Hyperiodrilus africanus, BEDDARD.

H. africanus, BEDDARD, Q. J. M. S., vol. xxxii, 1891, p. 236.

Definition. *Length, about* 100 *mm. No pigment in the skin. Spermiducal glands furnished with muscular ducts opening into bursa. Hab.—Lagos and Bismarcksburg, W. Africa.*

Genus HELIODRILUS, BEDDARD.

DEFINITION. **Setae paired, those of ventral pairs further apart than dorsal. Clitellum, XIV–XVII. Male pore between XVII/XVIII. Spermathecal pore on XI. Median papillae present on segments comprising clitellum and neighbouring segments. Gizzards in XVIII–XXIII; calciferous glands in XIII; pouches in IX–XI. Testes in X, XI, attached to posterior septa, enclosed in separate sacs. No penial setae. Spermatheca large; its extremity only enclosed in a sac, which is continuous with ovarian sacs.**

This genus agrees in a number of points with the last; MICHAELSEN has, indeed, in his revision of the 'Teleudrilini,' referred the two to one genus; it differs principally in

the presence of a series of papillae, instead of a penis, in the large spermatheca, which is but little enclosed by the sacs containing the ovaries, &c.; the position of the testes also distinguishes the two genera.

The male generative organs, so far as concerns the funnels and the sperm-ducts, agree entirely with those of the last species; the testes, however, are placed, as occasionally in the genus *Octochaetus* and *Acanthodrilus*, on the posterior face of the segment in which they lie; each testis is enclosed in a small sac which also surrounds the dilated part of the sperm-duct; these sacs may or may not have any connexion with the sperm-sacs which lie in the following segments; I observed none.

The female reproductive organs are in several ways remarkable. In the first place the spermathecae, instead of being a small sac as it is in *Hyperiodrilus*, is very large; it reaches from its opening on to the exterior (on the eleventh segment) back as far as the thirteenth segment. In this segment it has become much wider and is bent round to one side; the extreme tip is enclosed by a sac, which lies within a large sac connected with the general egg-conducting apparatus. Both these sacs are coelomic pouches; but it is curious to find two, one within the other. The outer sac narrows into a tube which communicates with the ovarian sac of its side of the body (the right); from the latter sac which, of course, contains the ovary, arises another tube which runs forward to the egg-sac; the same is the case with the ovarian sac of the opposite side of the body. The two ovarian sacs are connected as in *Hyperiodrilus* by a narrow tube which lies above the spermathecae, here a very narrow tube. There is one species—

Heliodrilus lagosensis, Beddard.

H. lagosensis, Beddard, Q. J. M. S., vol. xxxii, 1891, p. 253.

Definition. *Length, about* 100 *mm. A series of median papillae upon segments X–XV, more or less asymmetrical in position. Septa V/XIII, thickened. Hearts in XI–XIII. Spermiducal gland indistinctly divided into a glandular and muscular region. Hab.—Lagos, W. Africa.*

Genus ALVANIA, Beddard.

Definition. **Setae paired, ventral setae further apart than dorsal. Clitellum, XV–XVII. Male pore between XVII/XVIII, connected by a groove with two penes upon XIV or XV. Spermathecal pore on X. Calciferous glands**

in XIII; pouches in IX–XI; gizzards in five segments from XVIII. No penial setae. No true spermathecae (?). Large spermathecal sac communicating with egg-sacs and ovarian sacs, and giving off a tube passing round gut fusing with its fellow of opposite side.

This genus, like the last, contains only one species. As in *Hyperiodrilus* there are paired penes, which are to some extent variable in position; in one individual they were upon the fourteenth, in another upon the fifteenth segment. A groove starting from the male pore passes straight along the median ventral line of the body dividing just at the penes into two branches which go to each penis.

The testes are attached to the anterior wall of segments x, xi; both are enclosed in sacs, which also include the sperm-duct funnel; the latter is, as in *Hyperiodrilus* and several other genera, dilated before their termination in the funnel and traverse the septum, from which the funnel depends, twice; the funnel being thus situated a segment behind that which it ought to occupy. I have, however, pointed out in considering *Hyperiodrilus* that this difference from other worms may be more apparent than real, since the cavity of the sperm-sac really belongs to the body cavity of the segment in front of that in which it lies.

The female organs of generation are rather different from the corresponding organs of other genera. The ovaries are each enclosed in a sac which passes into a tube soon dilating somewhat; from this dilatation a narrow tube passes forward and communicates with the long spermathecal sac; this sac is divided into two parts by a median constriction; at this constriction the thickness of the lining epithelium is much increased, so much so as to obliterate the lumen. There is thus apparently no connexion between the narrower anterior section of the spermathecal sac and the broader hinder part. Possibly, however, the arrangement is such that the sperm can force its way in the one direction, but is unable to make way in the reverse direction. It is also conceivable that the division of the sac corresponds to the distinction between an epidermic and a mesoblastic portion of the pouch. From the dilatation on the ovarian tube already referred to arises a widish tube which passes round the gut and unites with its fellow on the opposite side. Another tube passes into the egg-sac, with which, of course, is connected the oviduct; the latter, however, also opens into the 'Eitrichterblase' (= the dilated sac). The oviduct has the peculiarity of possessing a diverticulum bound up in the same sheath with it; with this may be compared the diverticulum of the sperm-duct in *Phreodrilus* (cf. p. 273).

Alvania millsoni, BEDDARD.

A. Millsoni, BEDDARD, Q. J. M. S., vol. xxxiv, 1893, p. 271.

Definition. *Length, 2 in. No integumental pigment. Setae on seventeenth segment absent, the lateral setae of segments XV, XVI also absent. Hab.—Lagos.*

The above definition of the species is, of course, not insisted upon as being of more than temporary value.

Genus TELEUDRILUS, ROSA.

DEFINITION. Setae in eight series. Male pore on XIX. Spermathecal pore on XIV/XV. Calciferous glands paired in XIII, unpaired pouches in IX–XI. Ovarian sac communicating with egg-sac. Spermiducal glands opening into a terminal bulbus of complicated structure. No penial setae.

This genus was the second genus of the family to be described. It contains only one species, for a knowledge of which we are entirely indebted to ROSA. The female organs of this genus show certain peculiarities. The sacs which involve the ovaries lead through a slender duct to the egg-sacs, and not to the spermathecal sacs; the oviducal funnel opens partly into the egg-sacs, and partly into the somewhat dilated end of the egg conduit, which is, I presume, the 'Ovarialblase' of MICHAELSEN; from the funnel the oviduct passes to the exterior, opening on to the intersegmental groove xiv/xv. The spermathecal sacs open on to the exterior through a muscular walled terminal sac as in other Eudrilidae; from each spermatheca, near to where it merges into the atrium, arises a short diverticulum which ROSA states to end near to the egg-sacs; it seems possible that these supposed diverticula really open into the egg-chamber; that, at any rate, is what the analogy of other species of Eudrilids would suggest.

The male organs of *Teleudrilus* conform generally to the type met with in the more highly organized members of the family; there are two pairs of testes; the two pairs of sperm-ducts perforate the septa to which are attached the testes twice, and the proximal part of the duct forms a rather dilated chamber. The two pairs of sperm-sacs depend from septa x/xi, xi/xii, the anterior pair of testes appear to be enclosed in a delicate sac which communicates with the anterior sperm-sacs. The terminal apparatus is perhaps more complicated than is usual; there are two spherical

chambers divided by a constriction, into which is inserted the sperm-duct; it is the posterior chamber which opens externally. The anterior is called by ROSA 'Bulbo del pene,' the posterior 'borsa copulatrice'; between the two, as already said, are inserted the two spermiducal glands which open in reality into the anterior. The anterior chamber of the copulatory apparatus has thick walls lined by a low epithelium, and formed principally by a layer of muscle disposed in alternately longitudinal and circular directions; ROSA suggests—and I think with much reason—that this is the homologue of the 'Y-shaped gland' of *Eudrilus*, and in that case it will, on my view, be really comparable to the muscular sac found opening on to the penis of *Stuhlmannia*. The fibres of the muscular walls of the terminal chamber of the male efferent apparatus are mainly longitudinal in direction; this gives to the organ a 'mother-of-pearl' appearance when viewed without magnification.

The dorsal vessel of *Teleudrilus* is double in the anterior segments of the body, as far back as the fourteenth segment, but the two halves are united at each dissepiment. The nephridia open on to the exterior by visible orifices.

Teleudrilus ragazzii, ROSA.

T. Ragazzii, ROSA, Ann. Mus. Civ. Genova (2a), vi, 1888, p. 572.

Definition. *Length, 100 mm.; breadth, 4 mm.; number of segments, 145. Clitellum, XIV–XVII. Nephridiopores open by dorsal series of setae, commence in V. Gizzard in VII. Last hearts in XI. Hab.—Let-Marefia, Scioa, Abyssinia.*

The anatomy of this worm is to a great extent figured by ROSA in his only paper upon the species.

FAMILY GEOSCOLICIDAE[1].

DEFINITION. **Oligochaeta of various sizes, sometimes aquatic. Setae 8 in a segment, paired or irregular in arrangement. Clitellum saddle-shaped except in *Diachaeta* and *Ilyogenia*, usually rather extensive, often furnished with modified setae. Nephridia always paired, rarely more than one pair in a segment. Gizzard anterior. Male pores generally within the clitellum, with or without spermiducal glands. Spermathecae without diverticula.**

[1] ROSA writes the name of the family Geoscolecidae.

The Geoscolicidae form a family which is easily to be defined; very few of the characteristic features of the group are to be seen in other worms. There is, however, no one character found in *all* the Geoscolicidae, which is absolutely distinctive of the family. The definition given above shows a collection of characters which are nowhere else met with. The characters which are found in all the Geoscolicidae without exception are the following:—

(1) Setae not more than eight in a segment[1].

(2) Nephridia never diffuse, always paired (*two* pairs in *Brachydrilus*).

(3) Spermatheca without diverticula.

(4) Gizzard (or gizzards) in middle of oesophagus.

These four characters could not be applied to any other family; the Eudrilidae and Lumbricidae are only just out; the former by reason of (2), the latter of (4). In the following list are characters found in a large number of genera (the number indicated in brackets), but sometimes not unknown outside the group.

(1) Setae ornamented (9).	This occurs only in *Deodrilus*, and rarely in *Perionyx*.
(2) Clitellar setae differentiated in some way (nearly all Geoscolicids).	*Lumbricus*, *Allolobophora*, *Allurus*.
(3) First nephridium modified to form a large gland, which sometimes opens into buccal cavity.	This is found in *Acanthodrilus*; *Octochaetus*, and in connexion with buccal cavity in other Megascolicids with diffuse nephridia; also in *Lybiodrilus*.
(4) Nephridia commonly specialized into two series, those of anterior segments being different in some particular from those which follow.	
(5) Setae irregular in arrangement (4).	In tail region of a few Cryptodrilids.
(6) Setae defective on a few anterior segments (8).	This is seen in *Deodrilus*.
(7) Sperm-sacs long, extending through several segments (4).	Found also in *Typhaeus* and in *Polytoreutus*.
(8) Spermathecae far back, in neighbourhood of gonads (8).	This occurs in all Eudrilids, and is characteristic of Lumbricidae.

I discuss the affinities of the family under Lumbricidae and Eudrilidae (qq. v.).

[1] The occasional occurrence in *Onychochaeta* of nine setae is not perhaps a constant exception.

This family of Oligochaeta contains a considerable number of well-marked genera; with the exception of the genera *Hormogaster* and *Criodrilus*, they are all inhabitants of the Tropics both of the Old and New Worlds. The following are the genera which have been at present fully characterized:—

(1) **Pontoscolex** (=**Urochaeta**, E. P.), SCHMARDA.
(2) **Diachaeta**, BENHAM.
(3) **Onychochaeta**, F. E. B.
(4) **Trichochaeta**, F. E. B.
(5) **Geoscolex** (=**Titanus**, E. P.), F. S. LEUCKART.
(6) **Anteus**, E. P.
(7) **Microchaeta** (E. P.), F. E. B.
(8) **Rhinodrilus** (=**Thamnodrilus**, F. E. B.), E. P.
(9) **Urobenus**, BENHAM.
(10) **Brachydrilus**, BENHAM.
(11) **Hormogaster**, ROSA.
(12) **Glyphidrilus**, HORST.
(13) **Callidrilus**, MICHAELSEN.
(14) **Kynotus**, MICHAELSEN.
(15) **Bilimba**, ROSA.
(16) **Tykonus**, MICHAELSEN.
(17) **Ilyogenia**, F. E. B.
(18) **Annadrilus**, HORST.
(19) **Sparganophilus**, BENHAM.
(20) **Siphonogaster**, LEVINSEN.

In addition to these genera, of which adequate descriptions exist, there are a few of the worms so imperfectly described by KINBERG, which may possibly belong to the same family. These are:—

Tritogenia.
Geogenia.

The most aberrant type is undoubtedly *Hormogaster;* this genus has been recently studied by ROSA, who has pointed out several characters which it shares with the Lumbricidae. The most marked of these is perhaps the position of the male reproductive pores; these pores lie, in the genus under consideration, in the groove separating segments xv and xvi; so far, there is a resemblance to the Lumbricidae; there is a further likeness to the genera of that family in the fact that the spermathecae are in segments x, xi, and xii; in his first note (**32**) upon

Hormogaster, ROSA considered it to form a passage between the 'anteclitellians' and the 'intraclitellians;' a few months later he remarked (**20**): 'Sta fra i pre- ed intraclitelliani, ma e più vicina a questi ultimi. Non e strettamente affine a nessuna forma nota ma si accosterebbe al genere Urobenus (BENHAM) se la posizione assegnata dal BENHAM alle vesicole seminali e ai padiglioni per questo genere potesse considerarsi inesatta.' This position is maintained in the definitive memoir upon the worm (**7**). I am disposed to agree with ROSA in placing this genus between the Lumbricidae and the Geoscolicidae, but it does not seem to me that there are strong grounds for naming any one genus of Geoscolicidae as nearer to it than any other. Its habitat would suggest affinity with the Old-World genera; and it may be noted that it agrees with these in the presence of egg-sacs and in the position of the spermathecae; these organs, it is true, are paired and large, whereas in the Old-World genera which have spermathecae they are generally small and numerous, and, if paired, are still small. On the whole, the characters of the genus, as compared with those of other Geoscolicidae, are so peculiar that it ought perhaps to be placed in a distinct subfamily—Hormogastridae.

The remaining genera of the family appear to me to be capable of arrangement in two subfamilies, of which one is confined to the Old World, the other nearly confined to the New World; the division which is adopted here is that of ROSA; I myself (**39**), subsequently to ROSA in point of the time of publication, but independently, arrived at a nearly identical view; but, before entering into this, I may refer to BENHAM'S classification (**1**), only, however, to reject it.

BENHAM (1) divided the Geoscolicidae of ROSA into two groups, which were named Geoscolicidae and Rhinodrilidae; these were defined as follows:—

Family VII. Geoscolicidae, ROSA (=partly *L. intraclitelliens*, E. P.,=partly Eudrilidae, CLAUS, VEJDOVSKY=partly Geoscolicidae, ROSA).

The eight setae have a tendency to separate, or even to be arranged alternately in consecutive segments, either throughout the body or only posteriorly.

The clitellum commences behind somite xiv usually, and extends over nine or more somites, intersegmental grooves not being obliterated.

The sperm-sacs are very long; there is but one pair of testes and rosettes; the genital pores very small, and may be accompanied by glandular swellings.

A few of the anterior nephridia are larger than the following, and may even be collected into a mass forming a peptonephridium.

The typhlosole is a mere dependent fold.

Family Rhinodrilidae, mihi (= partly *L. intraclitelliens*, E. P., partly Eudrilidae, CLAUS, VEJDOVSKY, ROSA).

The eight setae are in four couples, the individual setae of each couple being close together.

The clitellum, incomplete ventrally, commences in front of somite xviii, and occupies ten or more somites.

The spermiducal pores are behind somite xviii (with the exception of *Hormogaster*), and are usually nearly in the middle of the clitellum.

There are two or more pairs of sperm-sacs, and two pairs of testes and rosettes.

The spermathecae are either small, or, if large, are quite simple, without appendices.

The gizzard is in front of somite x.

Nephridia are provided with a large duct, usually produced into a caecum; nephridiopores are in a line with the outer couple of setae (except in *Hormogaster*).

To the first family belong the genera *Geoscolex*, *Urochaeta*, *Diachaeta;* to the second the genera *Rhinodrilus*, *Microchaeta*, *Urobenus*, *Hormogaster*, *Brachydrilus*.

It will be noted in the first place, that *Hormogaster*, though referred to the second group, differs in two important particulars from the remaining genera of its family; these are duly mentioned by BENHAM, but a third point of difference has escaped his attention; this is the arrangement of the setae. *Hormogaster* cannot be included in this family or in BENHAM'S Rhinodrilidae; its isolated position must, I think, be allowed.

With regard to the characters of the two families Geoscolicidae and Rhinodrilidae, the most important distinction is the double nature of the male organs of generation in the Rhinodrilidae, and the single pair of testes, sperm-ducts, &c. in the second family; if we regard the presence of one or two sets of gonads and ducts as being of little importance (as I think must be done in view of such forms as *Kerria spegazzinii*), then there is not much left by which to distinguish the two families; the position of the gizzard in front of the tenth segment does not separate the second from the first of BENHAM'S two families, for in *Pontoscolex* (= *Urochaeta*) as he himself correctly notes, the gizzard is in the seventh segment; the characters of the spermathecae are no more useful in differentiating the Geoscolicidae from the Rhinodrilidae—as stated by BENHAM; finally, the anterior nephridia—the first pair at any rate—of *Rhinodrilus* are larger than the following; this pair of nephridia are, as in *Pontoscolex*, modified into a 'peptonephridium.'

At about the same time as this arrangement of the Geoscolicidae was published by BENHAM, I (**26**) divided the group 'Geoscolicini' (= ROSA'S family Geoscolicidae) into three families, viz.:—

I. Urochaetidae.

Setae irregular in distribution either throughout the whole body or after the first ten segments or so. Prostomium absent. Spermathecae, three pairs. Calciferous glands, three pairs. Nephridia with sphincter. A mucous gland present, being first nephridium.

Genera—*Urochaeta*, *Diachaeta*, *Onychochaeta*.

II. Geoscolicidae.

Setae paired or distant (both conditions occurring in the same species). Prostomium present. Nephridia all alike.

Genera—*Geoscolex*, *Hormogaster*, ? *Glyphidrilus*.

III. Rhinodrilidae.

Setae paired or distant. Anterior set of nephridia different from posterior.

Genera—*Microchaeta*, *Brachydrilus*, *Urobenus*, *Rhinodrilus*, ? *Anteus*.

Though I believe that there is nothing in the above definitions contrary to fact, the classification there suggested no longer commends itself to me; indeed, I pointed out at the time that these families were not so satisfactory as those of the Acanthodrilini. The two last families are the

most unsatisfactory; but there is no need to criticize the arrangement in detail. ROSA'S views are thus expressed (**20**) by him:—

'Questa famiglia (Geoscolicidae) venne accettata tal quale dal BEDDARD e dal MICHAELSEN, solo il BENHAM credette di doveria dividere in due "Geoscolicidae e Rhinodrilidae." Frattanto io credo che essa si dovrebbe dividere in modo affato diverso, mettendo in un gruppo i generi in cui le spermateche conservano la solita posizione anteriore ai testes, e nell' altro quelli in cui le spermateche si portano all' indietro ed hanno tendenza a moltiplicarsi, presentandosi ad ogni intersegmento in numero superiore a due, talora in numero grandissimo.

Questi due gruppi avrebbero fra loro lo stesso rapporto che hanno i Criptodrilini (*Cryptodrilus*, *Pontodrilus*, ecc.) cogli Eudrilini (*Eudrilus*, *Teleudrilus*, ecc.).

Le forme tipiche del primo gruppo sono tutte americane, appartenendovi i generi *Pontoscolex* (*Urochaeta*, *Diachaeta*, *Onychochaeta*), *Rhinodrilus*, *Urobenus* ed anche i generi *Anteus* e *Geoscolex*, che veramente sembrano mancare di spermateche, ma che pel complesso dei loro caratteri sono affini ai precedenti.

Lė forme tipiche del secondo gruppo sono proprie della Malesia, dell' India di Madagascar e dell' Africa orientale. Vi appartengono i generi *Kynotus*, *Callidrilus*, *Glyphidrilus*, *Bilimba*, *Brachydrilus* (loc. ignota).

Forme intermedie sono le *Microchaeta*, proprie dell' Africa australe, di cui alcune specie hanno spermateche numerosi ad ogni intersegmento, mentre altre (*M. Benhami*, ROSA, di loc. ignota) le hanno in due sole serie, ed anche l' *Hormogaster*, che ha pure spermateche in sole due serie, ma poste le due prime paia ai lati dei testes e l' ultimo dietro ad essi. . . . Una forma *incertae sedis* e l' *Eminodrilus equatorialis*, di Karague (Equatoria).'

With these views I have already (**39**) expressed my concurrence. And I have seen no reason for changing this opinion. The only matter in which I differ from ROSA is that I do not regard *Microchaeta* as intermediate; *Hormogaster* may be so. I call the two subfamilies Geoscolicinae and Microchaetinae. The first family, Geoscolicinae, includes my two families Urochaetidae and Geoscolicidae—*Hormogaster* and *Glyphidrilus*, but + *Urobenus*, *Rhinodrilus*, and *Anteus;* it equals BENHAM'S Geoscolicidae + the genera *Rhinodrilus* and *Urobenus*. It includes, therefore, the following genera:—

(1) **Pontoscolex** (= **Urochaeta**), SCHMARDA.
(2) **Diachaeta,** BENHAM.
(3) **Onychochaeta,** F. E. B.
(4) **Trichochaeta,** F. E. B.
(5) **Rhinodrilus** (= **Thamnodrilus**), E. P.
(6) **Anteus,** E. P.
(7) **Geoscolex** (= **Titanus**), LEUCKART.
(8) **Urobenus,** BENHAM.
(9) **Tykonus,** MICHAELSEN.
(10) **Sparganophilus,** BENHAM.
(11) **Ilyogenia,** F. E. B.

All these genera agree to differ from the next subfamily in these characters:—

(1) Spermathecae, one to four pairs, placed in neighbourhood of gizzard.

(2) No copulatory papillae.

These two characters are nearly absolutely distinctive; there are, in addition to these, a few other characters, which, without being found in all the genera belonging to this subfamily, are not found in any of the genera belonging to the second subfamily of the Geoscolicidae.

Thus the sperm-sacs are frequently a single pair of sacs which are of very considerable length; in *Trichochaeta*, for example, they occupy as many as twenty segments; the irregular distribution of the setae, often met with in this subfamily, does not occur in the Microchaetinae. The statement that there are no copulatory papillae requires some explanation; MICHAELSEN (**10**) has described in *Anteus papillifer* numerous papillae on the segments of the clitellum and on a few segments in front of the clitellum; these are formed round modified sexual setae. In the second subfamily of the Geoscolicinae, for instance in the species *Kynotus michaelsenii*, the sexual setae are provided with glandular sacs, having thick muscular walls, and recalling the spermiducal glands of other Oligochaeta.

It is doubtful, however, how far this distinction can be retained, having due regard to the structure of MICHAELSEN'S *Anteus callichaetus;* in this species MICHAELSEN (**10**) describes the presence in segments xviii–xx of five pairs of 'unregelmässig kugelige Taschen, deren Wandung ein drüsig-zottiges Aussehen hat,' a description which might apply to glands such as those which occur in the genus *Perichaeta* in connexion with the genital papillae, as well as to pouches like those of *Kynotus* and *Microchaeta*. And though, as I have pointed out in discussing the spermiducal glands of the Oligochaeta (p. 113), it is quite possible that the glands in *Perichaeta* are referable to the same category as those of *Microchaeta*, &c., there are obvious differences of detail.

A good deal of stress has been laid upon the position of the nephridiopores, although the fact that they alternate in position from segment to segment in more than one genus tends to throw doubt upon the usefulness of this character; it may be useful to see how far this character can be made use of in dividing up the genera of the present family. We have not complete information.

It will be noticed from the accompanying table that all the New-World genera, with the exceptions of *Geoscolex* and *Tykonus*, agree in possessing nephridia which open in front of one or other of the five lateral setae; now it is interesting, if not significant, that both these genera present some feature of affinity to the Old-World Geoscolicidae; *Geoscolex* agrees with *Siphonogaster* in having no spermathecae, and

GENUS.	POSITION OF NEPHRIDIOPORE.	GENUS.	POSITION OF NEPHRIDIOPORE.
Geoscolex	ventral setae	*Hormogaster* . . .	ventral setae
Anteus	lateral setae	*Microchaeta* . . .	lateral setae
Rhinodrilus . . .	,,	*Brachydrilus* . . .	ventral and lateral setae (two pairs of nephridia)
Urobenus	,,	*Kynotus*	ventral setae
Tykonus	ventral setae	*Callidrilus* . . .	,,
Pontoscolex . . .	lateral setae (setae irregular)	*Ilyogenia*	,,
Trichochaeta . . .	lateral setae	*Siphonogaster* . .	,,
Diachaeta . .	,,		

with *Kynotus* in having a spermiducal gland. *Tykonus* agrees with *Kynotus* in the fact that the setae do not commence until about the seventeenth segment, and in the presence of a 'bursa.' On the other hand, the Old-World genus, *Microchaeta*, is unique among the Old-World genera in having lateral nephridiopores. This genus is regarded by Rosa as being intermediate between his two subfamilies.

Among the Acanthodrilidae and other earthworms, the number and position of the contractile hearts are of systematic importance; the position of these varies also in the Geoscolicidae. As a rule the last pair are placed more anteriorly than is the case with the Acanthodrilidae or the Perichaetidae; in the genus *Ilyogenia*, for example, the last pair of these commissural vessels are in the eleventh segment. Unfortunately, the blood-vessels have not been studied in a considerable number of Geoscolicidae; we know, however, the position of the hearts in the following genera:—

The last pair	of hearts	in the genus	**Pontoscolex**	is in segment	xii.
,,	,,	,,	**Onychochaeta**	,,	xi.
,,	,,	,,	**Ilyogenia**	,,	xi.
,,	,,	,,	**Trichochaeta**	,,	xi.
,,	,,	,,	**Diachaeta**	,,	xi.
,,	,,	,,	**Urobenus**	,,	xiii.
,,	,,	,,	**Rhinodrilus**	,,	xii.
,,	,,	,,	**Tykonus**	,,	xii.
,,	,,	,,	**Anteus**	,,	xii.
,,	,,	,,	**Geoscolex**	,,	xii.
,,	,,	,,	**Microchaeta**	,,	xi.
,,	,,	,,	**Kynotus**	,,	xi.
,,	,,	,,	**Hormogaster**	,,	xi.
,,	,,	,,	**Callidrilus**	,,	xii.
,,	,,	,,	**Siphonogaster**	,,	xii.

Here it will be seen that there are no conclusions to be drawn; that is to say, no conclusions which bear upon the major divisions of the family; however, most of the Old-World genera agree, while the New-World forms are divisible into two sections, not perhaps altogether natural, since *Pontoscolex* is divorced from its certainly near ally *Diachaeta*.

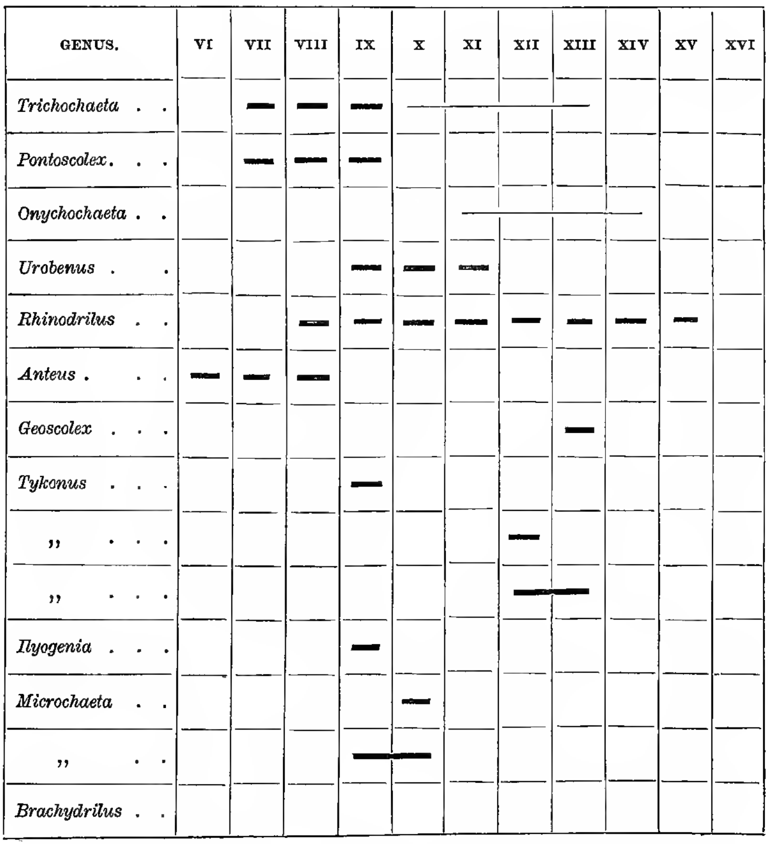
In *Trichochaeta barbadensis*, and possibly also in *T. hesperidum*, there are two sets of structures which may be compared to the 'Glands of Morren' in *Lumbricus;* in segments x, xi, xii the oesophagus is widened and its walls are much folded and vascular; in *T. barbadensis* I have found that this section of the oesophagus, which is not sharply marked off from the rest, produces crystals precisely like those which are excreted by the calciferous glands of other earthworms; there seems, therefore, to be very little doubt that this region of the oesophagus is, at any rate, the equivalent, so far as function goes, of the calciferous glands; but there is no formation of caeca opening into the oesophagus; we have simply a tract of oesophagus rather different in structure from the rest of the oesophagus; it requires, however, a very little change to convert this tract of gut into a series of glands like those of *Pontoscolex* for example. But the segments occupied by the calciferous glands of *Pontoscolex*, and those in which the oesophagus of *Trichochaeta* has undergone the modification just referred to are not the same; in *Pontoscolex* the glands in question lie in segments vii, viii, ix. We are fortunately relieved from the difficulty of deciding this matter by the occurrence in *Trichochaeta* of three pairs of rudimentary caeca in segments vii, viii, ix; the minute structure of these will be described (below); it is clear that they are the exact equivalents of the calciferous glands of *Pontoscolex*. It is, therefore, at least probable that in the Geoscolicidae generally, anteriorly situated calciferous glands are not the exact homologues of posteriorly placed calciferous glands. We can arrange the genera into two series according to the position of these glands, as will be seen from the table on p. 631.

1. Subfamily Geoscolicinae.

Definition. Spermathecae one to four pairs placed in neighbourhood of gizzard.

As already remarked, all the genera of this subfamily, with the exception of *Ilyogenia* from Natal, are tropical American in habitat, ranging from the West Indies even so far north as the Bermudas (*Onychochaeta*) to Brazil; they do not appear to occur in the more southern regions of that continent.

They are of various sizes: *Pontoscolex* being one of the smallest and *Geoscolex* the largest forms. The prostomium is not always present; this being nearly the only group of Oligochaeta in which this characteristically Chaetopod organ is occasionally deficient; the only other instance is *Deodrilus*. Those genera in which the prostomium is thus absent form a natural section of the subfamily; ROSA, indeed (**20**) puts these three



N.B.—It must be explained that the thick lines indicate paired caeca; the thin lines only slightly differentiated oesophagus. It is not, however, possible to institute a very inflexible demarcation between the one and the other.

genera, *Pontoscolex, Diachaeta,* and *Onychochaeta* into a single genus; I am not, however, inclined to follow him so far.

These three genera have also an irregular arrangement of the setae, at any rate in the posterior region of the body; if this did not also occur in *Trichochaeta*, a genus which possesses a long prostomium like that of *Rhinodrilus*, it would be, perhaps,

necessary to separate the three genera into a subfamily or to unite them into a single genus. The irregular disposition of the setae is not, however, a differential character of first-rate importance; for in some specimens of *Pontoscolex*, which do not appear from their size to be especially young, the setae are paired. This fact, first noted by Fritz Müller, has been also observed by myself. Moreover, in the genus *Trichochaeta* one species has and one has not this irregular disposition of the setae. As there are no other points which distinguish them from the other Geoscolicidae, it does not appear to be necessary to include them, as I formerly did, in a special subfamily. The four genera, *Geoscolex*, *Anteus*, *Rhinodrilus*, and *Urobenus*, agree in having paired setae which are usually ornamented; the last three of these are united by Michaelsen (10) into a single genus. I explain later my reasons for disagreeing with this fusion of three genera; but the views of Michaelsen serve to emphasize the very close relationship which exists between all three of them.

The anatomy of the different genera which are contained in this subfamily will be found treated of under the several genera. In this place the mutual relationships of these genera may be discussed.

This discussion will be facilitated by a study of the accompanying table, which shows the principal differences and resemblances:—

	PROSTOMIUM.	SETAE.	NEPHRIDIA.	GIZZARD.	CALCIFEROUS GLANDS.
Pontoscolex . .	o (?)	paired anteriorly, scattered posteriorly	a mucous gland present	vi	three pairs in vii, viii, ix
Diachaeta . .	o	scattered from the first	,, ,,	,,	o
Onychochaeta .	o	absent from five anterior segments; irregular; very large posteriorly	,, ,,	,,	one in xii–xiv
Trichochaeta .	long and retractile	scattered, with peculiar ornamentation, or paired	,, ,,	,,	absent, or one in x–xii, with rudimentary caeca in vii–ix.
Rhinodrilus .	present, retractile	paired, sometimes absent from first two segments	a mucous gland sometimes present following nephridia, specialized into two series	ix	
Geoscolex . .	short	paired	no specialization	vi	one in xiii
Urobenus . .	,,	,,	specialized into two series	viii or ix	ix, x, xi, or absent
Tykonus . . .	,,	paired, defective on anterior segments	?	vi	ix or xii
Anteus . . .	,,	paired	specialized into two series	,,	xii, xiii, or three pairs
Ilyogenia . .		,,	without end sac	o	ix

Three genera, viz. *Trichochaeta*, *Pontoscolex*, and *Geoscolex* (possibly also *Diachaeta*), agree in possessing only a single pair of testes and of ciliated funnels; there are also in these three genera a single and very long pair of sperm-sacs, especially long and thin in *Trichochaeta*, *Diachaeta*, and in *Geoscolex forguesi*[1]; these characters gain in importance from the fact that they occur always together; that is, there is no genus with elongated sperm-sacs, which has not also the male gonads confined to a single pair; furthermore, the state of affairs is very like what is to be met with in so many of the aquatic Oligochaeta; in the Tubificidae, for example, the testes are but one pair and the sperm-sacs in the same way occupy a large number of segments. I therefore regard this assemblage of characters as defining a central group. It is clear that the genus *Onychochaeta* comes very near to the genera *Trichochaeta*, and *Pontoscolex*, with which it agrees in the usually irregular arrangement of the setae, and in the presence of three pairs of spermathecae; on the other hand, the retractile proboscis of *Trichochaeta* is a point of affinity with *Rhinodrilus*, to which genus, excepting in this character, *Anteus* comes so near that it is difficult to separate them; *Geoscolex* leads towards the second subfamily of the Geoscolicidae, with which it agrees in the 'atrium,' to a less degree in the absence of spermathecae, and in the ventral position of the nephridiopores. In *Geoscolex*, also, the calciferous

HEARTS.	TESTES.	SPERM-SACS.	SPERMATHECAE.	OTHER STRUCTURES.
xi, xii	one pair in xii	long	three pairs in vii, viii, ix	integumental bodies present; setae bifid; posterior glands
viii-xi	[?	long, extending through twenty-six segments	three pairs in vi, vii, viii	
x, xi	x, xi	xi, xii	three pairs in vii, viii, ix	
,,	xi	extremely long, through fifteen or twenty segments	three pairs in vii, viii, ix, or ix, x, xi	posterior glands
xi, xii				copulatory setae and glands sometimes present
,,	(?) xi	one pair, long	o	large spermiducal gland
xii, xiii	x, xi	xii (xiii)-xiv (xvi)	vii-ix	a pair of caeca like those of *Perichaeta* in twenty-six posterior glands
xi, xii		xii	o, or in vii, viii	
		xi, xii	o	
x, xi	x, xi	ix, xii	ix	

[1] A comparatively little known species, possibly referable to a distinct genus (see below).

glands are limited to a single pair in the thirteenth segment, a difference from all other members of the subfamily. *Urobenus* is like *Pontoscolex*, and *Trichochaeta*, in having a series of posteriorly situated glands; a remarkable point in its structure is the existence of a pair of caeca in the same segment as that in which similar caeca occur in the not nearly allied genus *Perichaeta*, viz. the twenty-sixth. This last fact leads me to include MICHAELSEN'S *Anteus papillifer* in the genus *Urobenus;* in this species the setae are wanting upon the first few segments of the body; the only other members of the subfamily Geoscolicidae in which the same cephalization occurs is in my genus *Onychochaeta*, in *Tykonus* and (occasionally) in *Rhinodrilus;* these genera so far approach the subfamily Microchaetidae, where the absence of setae on the first few segments is not unfrequently met with. In view of the fact that the setae of the first few segments of the body are absent in worms, not by any means nearly related to the Geoscolicidae, e.g. the Naidomorpha, too much stress perhaps cannot be laid upon the resemblance. *Ilyogenia* might reasonably be regarded as a somewhat degenerate ally of *Rhinodrilus*.

The following tabular statement of the principal differences between the species of '*Anteus*' described by MICHAELSEN (**10**); his genus *Tykonus* and BENHAM'S (**3**)

	PROSTOMIUM.	SETAE.	CLITELLUM.
Anteus papillifer . .	large	begin in iii, not ornamented; on x–xvii and xxiv ventral setae longer and ornamented	xv–xxv
A. brunneus	long	not ornamented, except ventral setae of clitellum	xvi–xxiv
A. appemi . . .		ornamented, absent in anterior segments	xv–xxiv
A. callichaetus . . .	"	ornamented, absent in anterior segments; on xviii–xxii ventral seta larger and furnished with glandular pouches	xv–xxiv
Tykonus grandis. . .	large	ornamented, absent in anterior segments	xv–xxvi
Urobenus brasiliensis .	small	unornamented, longer on clitellum	xiv–xxvi

Urobenus, may precede a discussion as to the systematic position of this species referred to.

The most marked character common to several of these species is the absence of setae on some of the anterior segments. This is most marked in *Tykonus*, and the fact that in that worm the ventral setae do not commence until the thirteenth segment, while the dorsal do not appear until the twenty-sixth segment is the chief reason for distinguishing the genus, which 'in other respects stands near to the genus *Anteus*.' But we find that the same deficiency of setae anteriorly distinguishes

three of the species of *Anteus; in A. appuni* there are roughly the same number of segments devoid of setae as in *Tykonus,* though the lateral commence before the ventral setae; the reverse, however, is the case with *A. callichaetus,* and the setae are not deficient on so great a number of segments. It does not, therefore, appear possible to separate *Tykonus*, unless we include in it '*Anteus*' *appuni.*

I am of opinion that this character, which serves also in part to distinguish the New-World Geoscolicids, *Rhinodrilus* and *Onychochaeta*, and the Old-World *Microchaeta, Kynotus*, may be used also to distinguish *Tykonus* from its near allies. It will be noted from the above table that the two species which I propose to include within this genus *Tykonus* agree, furthermore, in having but a single pair of sperm-sacs; it may be that they have also but a single pair of testes, as the one character often goes with the other (e.g. *Pontoscolex* and *Typhaeus*). Of less importance is the fact that no one of the three species has more than two pairs of calciferous glands and spermathecae (? as to *Tykonus grandis* in respect of the latter character).

'*Anteus*' *papillifer* resembles *Urobenus brasiliensis* in having intestinal caeca in the twenty-sixth segment. This singular point of likeness to *Perichaeta* is to my mind a character worthy of being regarded as generic. The slight deficiency of setae

♂ PORE.	GIZZARD.	CAECA.	CALCIFEROUS GLANDS.	SPERM-SACS.	SPERMATHECAE.
xix/xx	ix and x (?)	xxvi	o	xiii, xiv, xv, xvi	vii–ix
,,	ix (?)	o	three pairs		,,
xx	v	o	one pair	one pair in ix	vii, viii
xix/xx (?)	ix, x (?)	o	two pairs	one pair in xi xiii	vii, viii, copulatory seta in vi–viii
xix/xx, bursa copulatrix	vi	o	one pair	one pair in xii	?
xx	viii	xxvi	three pairs	xii, xiii, xiv	vii, viii, ix

in the first named species (not found in *Urobenus brasiliensis*) cannot be compared to the great deficiency of setae in *Tykonus*[1]. These two species, moreover, appear to agree on the whole in the characters of the sperm-sacs.

Finally, I would not leave *Anteus brunneus* in the genus to which MICHAELSEN has referred it, but assign it to *Rhinodrilus*, where also I place *A. callichaetus*, on account of its modified copulatory setae and glands, which seem also to occur in *R. tenkatei.*

[1] Cf., however, the different species of *Kynotus* and *Microchaeta.*

Geogenia natalensis, KINBERG (Öfv. Svensk. Akad. 1866). I believe this species to belong to a genus different from any of those described in the present work. VAILLANT (**6**, p. 189) considers it to be synonymous with *Rhinodrilus*, but the alternating setae in the anterior part of the body, and its habitat (Natal), are opposed to this identification. On the other hand, the groove which is described as dividing longitudinally the first two segments, recalls a similar grooving of the first segments of *Rhinodrilus gulielmi* (see p. 640). The clitellum has two apertures on the ventral side, which probably means that there are spermiducal glands, otherwise the male pores would be hardly visible. This suggests that the worm may be a *Kynotus*, with which identification the absence of setae from the first few segments is not at variance. The ventral setae of clitellum are ornamented.

Eminodrilus equatorialis, BENHAM (Journ. R. Micr. Soc. 1891). This species, which comes from Karagua in Equatorial Africa, is known from the examination of only one specimen, which was sexually immature. It is two inches in length, and consists of about 190 segments. The setae are paired, those of ventral couples being further apart. Dorsal pores absent. Prostomium complete. The alimentary canal has a gizzard in v, and two pairs of calciferous glands; the intestine begins in xiii or xiv. The nephridia are paired, and open by the dorsal setae. There are fifty nephridia anteriorly. It has only one pair of testes (in xi), and sperm-sacs (in xii). Spermathecae were not found, nor were the male ducts traced beyond the end of septum xi/xii. BENHAM is possibly right in regarding this worm as a Geoscolicid, but, in the meantime, it might be a Cryptodrilid with the spermiducal glands not yet developed. He describes, however, 'peculiar sacs in viii and ix with several setae,' which suggests some of the African Geoscolicids.

Genus RHINODRILUS, PERRIER.

Syn. **Thamnodrilus,** BEDDARD.
? Geogenia, VAILLANT.
Anteus, MICHAELSEN.

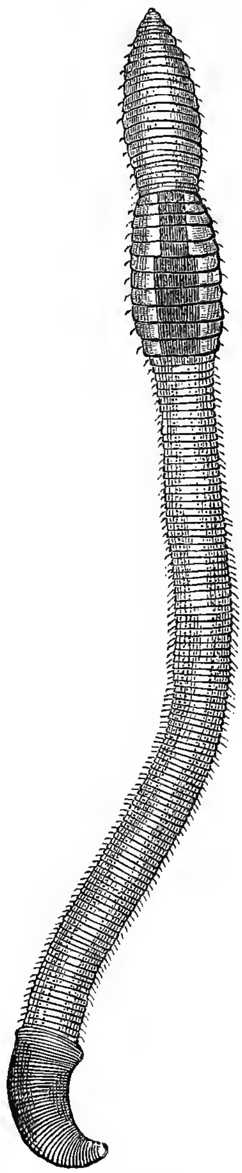
DEFINITION. **Setae paired, ornamented, those of clitellum usually longer and straighter. Prostomium very elongate, retractile within a sheath. First nephridia larger than following, sometimes opening into buccal cavity. Calciferous glands generally six or seven pairs. Spermathecae one to four pairs, placed anteriorly.**

This genus is distinguishable from all the remaining Geoscolicidae, with the sole exception of *Trichochaeta*, by the singular elongated prostomium; this organ by its great length recalls the prostomium of the two aquatic genera *Rhynchelmis* and *Sutroa;* it occurs in all three species of *Rhinodrilus*. PERRIER (**3**, p. 65) compares it with the cephalic appendage of *Stylaria proboscidea*, and insists that it has no analogy with the proboscis of marine Annelids. VAILLANT (**6**, p. 190, footnote), on the other hand, is of opinion, from his dissections, that this organ is an 'extroversion de la partie antérieure du tube digestif.' In *Rhinodrilus gulielmi*, I pointed out (**60**, p. 157) that the prostomium is retractile within the mouth cavity, appearing

in the retracted condition (see accompanying woodcut) as a rounded process nearly blocking up the mouth. This accords with VAILLANT'S observations rather than with those of PERRIER; the reader is also referred to the description of *Trichochaeta* (below), where a proboscis of a similar character exists.

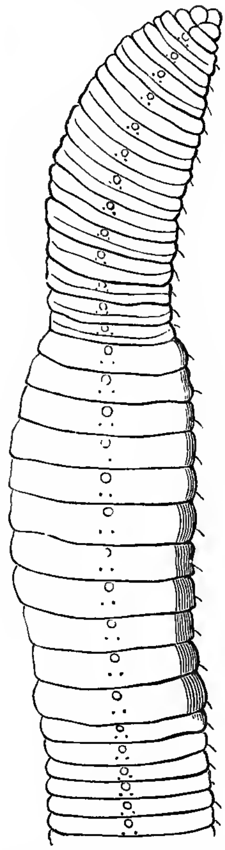
The clitellum (see woodcut, fig. 51) is, as in other Geoscolicidae, saddle-shaped; anteriorly the ventral area upon which there has been no development of glandular tissue, is narrower than it is posteriorly; the number of segments occupied by the clitellum is ten or eleven, commencing with the fourteenth; in *R. tenkatei* and *R. paradoxus* there is some doubt as to the limits of the clitellum. As in *Pontoscolex* and other genera the clitellar setae are usually longer, straighter, and more distinctly sculptured than the setae of other parts of the body; in *R. ecuadoriensis* alone there appear to be no differences between the setae of the clitellum and those which occur elsewhere. In *R. tenkatei* there are bundles of four setae replacing the ventral pairs of setae of the seventeenth, eighteenth, and nineteenth segments. These in all probability correspond to the copulatory setae (and glands) found in certain species of *Microchaeta*, *Tykonus*, and in *Kynotus*.

Fig. 51.



RHINODRILUS GULIELMI.
NAT. SIZE.

Fig. 52.



RHINODRILUS GULIELMI.
ANTERIOR SEGMENTS OF BODY.

The nephridia are paired; the first pair are larger than the following. In *R. ecuadoriensis* these nephridia open into the buccal cavity, as in *Octochaetus multiporus*. The following nephridia are separable (in *R. gulielmi* at any rate) into two series; the anterior series comprising fourteen pairs have a small funnel, a very long muscular duct, and no caecum. The fifteenth and the following nephridium have a larger funnel, a shorter muscular duct and a caecum.

As regards the reproductive organs the principal point to be noticed is that the spermathecae lie in front of the other organs of reproduction and that they are paired pouches of some size.

This genus is exclusively neotropical in its range; it has been brought only from the more northerly regions of the South American continent.

VAILLANT (6) has proposed to unite *Rhinodrilus* with KINBERG'S genus *Geogenia;* I do not think that this identification is possible; the principal reason which led VAILLANT to this conclusion is the fact that in both the genera there are specialized setae near to the male pores. This is, of course, a common character with the Geoscolicidae, and is by no means enough upon which to base an affinity so close as VAILLANT suggests between the New-World and the Old-World species described by KINBERG and PERRIER respectively. Moreover, as VAILLANT does not forget to point out, *Geogenia* has alternate setae in the anterior segments of the body.

I myself have suggested (28) the desirability of uniting *Rhinodrilus* with *Anteus*. I am not now so convinced that this step, supported also by MICHAELSEN (10), is quite permissible; it is true that the differences between species referred to *Rhinodrilus* and species referred to *Anteus* are not very great; but, as a matter of fact, it is not an easy task to distinguish *Geoscolex* from *Anteus*, and *Anteus* from *Tykonus;* all these South American genera seem to fade into one another; that is to say, the extreme types of each are only to be separated by small differences. If we compare *Rhinodrilus* and *Anteus*, it appears that there are hardly any points which distinguish them; while we had only PERRIER'S (3) description of *Anteus* with which to compare *Rhinodrilus*, it was an easy matter to separate the two; but the description of *A. heterostichon* by myself (28), and the additional facts in the structure of *A. gigas* given by HORST (6), bring the two closer together. The chief distinguishing mark is undoubtedly the long retractile prostomium of *Rhinodrilus*.

MICHAELSEN (10), who proposes to unite not only *Anteus* and *Rhinodrilus*, but also *Urobenus*, remarks that the prostomium varies, even in individuals; but he gives no details as to the exact form of the prostomium in the species of which he treats; with regard to '*Anteus*' *brunneus*, however, he speaks of it as retracted, 'mehr oder weniger weit eingezogen.' This suggests a *Rhinodrilus*-like prostomium; and, as a matter of fact, this species appears to me, on other grounds, to be referable to the genus *Rhinodrilus*.

I referred in the paper already quoted to the apparently greater number of calciferous glands in *Rhinodrilus;* this difference no longer holds, for *R. brunneus* (MICHAELSEN) has, like *Anteus*, three pairs only.

PERRIER (3, p. 65) does not consider that the characters drawn from the cephalic lobe are sufficient to separate genera alone; but I think it possible from the remark, 'cette trompe n'a du reste aucun rapport avec l'appareil digestif,' that PERRIER did not thoroughly investigate the structure of the peculiar prostomium of *Rhinodrilus*, or he would possibly have given more weight to its value as a diagnostic character.

The only remaining character of importance which serves to separate *Anteus* and *Rhinodrilus* is the absence of spermathecae in the former genus. These structures can hardly have been overlooked by three persons, PERRIER, HORST, and myself, if they were really there; and it will be observed that they are absent in two unquestionably different species; their absence in one species would have been of less importance, since we know that these organs may occasionally be absent in particular species of a genus where they are usually present (see p. 126). On the whole, therefore, I am inclined to retain both the genera *Rhinodrilus* and *Anteus*. I have already discussed (p. 634) the proper position, according to my view, of the several species of '*Anteus*' recently described by MICHAELSEN.

The genus contains eight well-marked species, which there is no difficulty in distinguishing.

(1) Rhinodrilus paradoxus, PERRIER.

R. paradoxus, PERRIER, Nouv. Arch. Mus., 1872, p. 66.

Geogenia paradoxa, VAILLANT, Annelés, p. 190.

Definition. *Length,* 150 *mm. Male pores, XIX/XX. Clitellar setae long and straight, with more marked ornamentation than ordinary setae. Three pairs of calciferous glands. No spermathecae* (?).—*Hab. Caracas.*

This is the type species of the genus. Its anatomy has been described by PERRIER in his classical paper upon the terricolous Oligochaeta (**3**), to which account a few details were added later (**5**). The additional matter chiefly relates to the calciferous glands, which in the earlier paper were erroneously described as hearts divisible into two chambers compared to an auricle and a ventricle. There are, however, still lacunae in our knowledge of *R. paradoxus;* it is not certain, for example, how many segments are occupied by the clitellum. PERRIER found only three segments—the nineteenth, twentieth, and twenty-first—referable to the clitellum, but, as he describes modified setae upon the seventeenth segment, it is clear that the clitellum must extend at least as far forwards as to this segment. There appears to be but one pair of testes and sperm-ducts. PERRIER was unable to find any spermathecae at all, and suggests the possibility of the worm being hermaphrodite. I have, however, pointed out in the case of *R. gulielmi* that the spermathecae are not always to be found even in mature individuals; and BENHAM was of opinion (**11**) that the failure on the part of PERRIER to find these organs was possibly to be explained by small size and by a position, as in *R. ecuadoriensis,* close to the ventral median line.

(2) Rhinodrilus tenkatei, HORST.

R. tenkatei, HORST, Notes Leyd. Mus., ix, 1887, p. 101.

Definition. *Length,* 115 *mm.; number of segments,* 160. *On segments XVII, XVIII,*

XIX bundles of four copulatory setae, long and ornamented, like the other clitellar setae. Six pairs of calciferous glands. Three pairs of spermathecae in VII, VIII, IX. Hab.—Surinam.

The distinguishing character of this species is the bundles of copulatory setae, which, as has already been suggested, represent the copulatory organs of *Microchaeta*. Possibly when more fully mature specimens are accessible these bundles of setae will be found to possess glands, as in *Microchaeta*.

(3) Rhinodrilus gulielmi (Beddard).

Thamnodrilus Gulielmi, Beddard, P. Z. S., 1887, p. 154.

R. (**Thamnodrilus**) **Gulielmi,** Beddard, P. R. Phys. Soc., 1891, p. 269.

Definition. *Length,* 150 *mm. Clitellar setae longer and with more marked ornamentation than body setae. Clitellum, XV–XXV. Six pairs of calciferous glands in IX–XIV. One pair of spermathecae in VII. Hab.—British Guiana.*

This species was first referred by me to a distinct genus—*Thamnodrilus;* it is, however, quite a typical *Rhinodrilus,* though easily separable from the other species of the genus. The colour of the preserved worms is purplish on the dorsal and reddish yellow on the ventral surface. The species is a stout one (see woodcut figure on p. 637 above). The segmentation is a little difficult to understand. In my paper upon this worm I placed the first pairs of setae as well as the first nephridiopores upon the second segment of the body; the (supposed) buccal segment lying in front of this is, however, divided into two by a transverse furrow. The fact that these two rings were both marked by a longitudinal groove led me to infer that they were both parts of but one segment. If, however, we allow that the supposed buccal segment is in reality the equivalent of two segments both of which, as in *R. ecuadoriensis,* are devoid of setae, the position of the organs will be more in accord with that of other species. For example Benham (**11**) places the first pair of nephridiopores upon segment iv, the first pair opening into the buccal cavity. In the species here described the first pair do not open into the buccal cavity but on to the exterior; and the segment upon which they open will be in this case the third. This will bring the second pair to the fourth segment—exactly what we find in *R. ecuadoriensis.* The last segment of the clitellum will be, if this enumeration is correct, the twenty-sixth instead of the twenty-fifth; and Horst names this as the last clitellar segment of *R. tenkatei.* On the other hand, I am not able to be quite certain about the correctness

of this revision of the segmentation of *R. gulielmi* since I have not had the opportunity of again fixing the position of the ovaries, &c., in the light of the proposed alteration.

(4) **Rhinodrilus distinctus** (Ude).

Anteus distinctus, Ude, Z. wiss. Zool., 1893, p. 58.

Definition. *Length,* 70 *mm.; diameter,* 7 *mm.; number of segments,* 220. *Setae ornamented, the ventral pair of XXII long. Clitellum, XV–XXIII. Five pairs of spermathecae in VII–XI. Hab.—Antioquia.*

The prostomium of this species appears to show the distinctive characters of *Rhinodrilus.* There is a gizzard in vi, and the last pair of hearts are in xi. The tubercula pubertatis form a continuous ridge on segments xviii–xxii. Ude figures the clitellum, prostomium, setae, and a spermatheca.

(5) **Rhinodrilus brunneus** (Michaelsen).

Anteus brunneus, Michaelsen, Arch. f. Nat., 1892, p. 217.

Definition. *Length,* 125 *mm.; breadth,* 8 *mm.; number of segments,* 103. *Setae not ornamented except on clitellum; on clitellum ventral setae more strongly ridged than dorsal. Clitellum, XVI–XXIV. Three pairs of calciferous glands. Three pairs of spermathecae in VII–IX. Hab.—Caracas.*

This species differs from *R. paradoxa,* which it resembles in having three pairs of calciferous glands, in the absence of ornamentation upon the ordinary setae of the body. The nephridia commence in the third segment. There is a gizzard in segment ix.

Michaelsen states that the prostomium is prolonged into a proboscis, which is sometimes extended and at other times retracted; this leads me to infer that it possesses a prostomium like that of *R. gulielmi.* For this reason, and also because it has spermathecae, I refer the species to the genus *Rhinodrilus,* and remove it from *Anteus.*

(6) **Rhinodrilus ecuadoriensis,** Benham.

R. ecuadoriensis, Benham, Ann. and Mag. Nat. Hist., March, 1892, p. 23.

Definition. *Length,* 75 *mm.; number of segments,* 100. *Setae absent from first two segments; no modified setae upon clitellum. Clitellum, XIV–XXV. Seven pairs of calciferous glands. Four pairs of spermathecae in V–VIII. Hab.—Cayambe, Ecuador;* 14,000 *feet.*

This species has been fully described and figured by Benham. The principal differences which distinguish it from other species are the absence of any specially modified setae, and the presence of seven instead of three or six pairs of calciferous glands. It is also remarkable for the fact that there are no setae until the third segment of the body. It may be, as I have already suggested, that *R. gulielmi* agrees with the present species in this peculiarity, which may even prove to characterize the genus. The typhlosole is curious: it is well developed, and instead of passing in a straight line along the dorsal wall of the intestine, its line of origin takes a spiral course round the wall of the gut.

The dorsal vessel communicates with the ventral by means of three peri-oesophageal trunks in segments viii, ix, x; there are two intestinal hearts in the two following segments. The dorsal vessel itself appears to end abruptly behind the gizzard; but this unusual divergence from the normal requires confirmation. It is figured by Benham as ending at the first pair of peri-oesophageal trunks.

(7) Rhinodrilus callichaetus (Michaelsen).

Anteus callichaetus, Michaelsen, Arch. f. Nat., 1892, p. 220.

Definition. *Length,* 105 *mm.; breadth,* 5 *mm.; number of segments,* 105. *Setae ornamented; ventral commence in segment V, dorsal in segment VIII. Nephridiopores begin in segment III, placed in front of lateral setae. Clitellum, XV–XXIV. Male pores on XIX–XX (?). Two pairs of calciferous glands. In segments XVIII–XXII pairs of glands, between which are sacs of long ornamented setae. Spermathecae in VII, VIII, in the neighbourhood of which are copulatory setae like the posterior setae. Hab.—Caracas.*

This species is said to show very active movements when alive like a *Perichaeta*, and to be dark-violet coloured. The gizzard is in ix, x. Septa all very slender, those of anterior segments seem to be reduced.

(8) Rhinodrilus proboscideus, Schneider.

R. proboscideus, Schneider, SB. Dorpat. Nat. Ges. Jhrg., x, 1893, p. 44.

Definition. *Length,* 190 *mm.; number of segments,* 130. *Setae smooth, excepting pairs of ventral side of XIX–XXI. Clitellum, XV–XXIV. Sperm-duct pores on XX; oviducal pores on XVII/XVIII. Unpaired ovary in XVII. Spermathecae two pairs in VII, VIII. Hab.—Trinidad.*

This very remarkable species is referred to *Rhinodrilus* with some little doubt; the principal reason for so referring it is the long retractile prostomium, which, as

the describer of the species tells us, can be completely withdrawn into the anterior part of the gut. Although this is also a character of *Trichochaeta*, the smooth setae do not permit of the species being placed in that genus. The position of the oviducal pores is most unusual. So too are the sperm-sacs of segments xv, xvi. As, however, we are not unacquainted with exceptional differences, peculiar to one species, of this kind, it is perhaps not a reason for excluding *R. proboscideus* from the genus *Rhinodrilus*.

Genus GEOSCOLEX, F. S. LEUCKART.

Syn. **Titanus,** PERRIER.

DEFINITION. Setae paired, diverging posteriorly, ornamented. Sperm-sacs long, one pair. No spermathecae. Sperm-duct opens on to exterior through a muscular sac.

The genus *Geoscolex* was first described, as regards its external characters only, by F. S. LEUCKART; in his classical memoir upon the terrestrial Oligochaeta PERRIER (**3**) instituted a new genus *Titanus* for a Brazilian earthworm, which ROSA (**31**) subsequently showed to be even specifically identical with LEUCKART'S *G. maximus;* the reasons for accepting this identification will be gone into under the description of the species *G. maximus.*

The main features which characterize the genus are mentioned in the above definition; the principal distinction from any other of the New-World genera is the existence of a terminal 'atrium,' through which the sperm-ducts open on to the exterior; unfortunately nothing whatever is known as to the histology of this organ. *Geoscolex* is also the only genus of New-World Geoscolicidae, excepting *Anteus* in which there are no spermathecae; but this character is of less importance as the spermathecae are absent from several species of earthworms, and from the genera *Siphonogaster* and *Criodrilus* in addition to *Anteus.* The long and single pair of sperm-sacs also occur in *Pontoscolex* and *Trichochaeta.*

There are two species—*G. maximus* and *G. forguesi.*

(1) Geoscolex maximus, F. S. LEUCKART.

G. maximus, F. S. LEUCKART, Zool. Bruchst. Heft ii, 1841, p. 104.

Titanus brasiliensis, PERRIER, Arch. d. Mus., 1872, p. 57.

Definition. *Length, four feet two inches. Clitellum, XV–XXIII. Sperm-sacs moderately long. Hab.—Brazil.*

This species was first described by LEUCKART, as has already been mentioned; ROSA has, however, conclusively shown that PERRIER'S *T. brasiliensis* is the same species. He has elaborately compared by extensive quotations the descriptions given by the two authors; the result of which is to show the identity of the worms described by both. It will be unnecessary to repeat this comparison here.

The worm is one of the largest known; LEUCKART considers that during life it may have been able to extend itself to eight or nine feet; the dimensions given in the definition of the species are sufficiently large.

The fact of the ornamentation of the setae is not noted by PERRIER; it was first described by myself (**28**); at about the same time, ROSA discovered setae upon the clitellum, which were to be distinguished by their slightly greater size, and by the ornamentation of the free extremity; he implies that the ordinary setae of the body do not show this ornamentation, though there is no positive statement upon the matter; it is not so, however.

The male pores are upon the eighteenth segment; the oviducal pores have been found by ROSA, who places them upon the fourteenth segment behind seta 2. LEUCKART had, however, previously noted their occurrence on that segment.

The alimentary canal is furnished with a single pair of calciferous glands in the thirteenth segment; these were at first taken by PERRIER (**3**) for a part of the circulatory system, but the error was afterwards rectified, as I omitted to point out in correcting it (unnecessarily) myself (**28**). The last hearts are in xii. The testes are presumably a single pair, as in any case the sperm-ducts are. The latter open on to the exterior by means of a thick-walled chamber, occupying three segments and constricted where it passes through the septa.

(2) **Geoscolex forguesi** (PERRIER).

Titanus forguesi, PERRIER, Arch. d. Zool. Exp., 1880, p. 217, footnote.

Definition. *Length,* 100 *mm. Clitellum, XV–XXII. Sperm-sacs enormously long. Hab.—La Plata.*

This species is at present very imperfectly known; we have only a few notes upon its anatomy chiefly contained in a short footnote appended to PERRIER'S memoir upon *Pontodrilus.* It agrees with the last species in some important characters, but appears to differ in others, which might be thought to be of generic value. Thus there is, as in *G. maximus,* a single pair of calciferous glands in the thirteenth segment; the last pair of hearts are in xii, and, are like the preceding pair, connected with the supraintestinal as well as with the dorsal vessel; the absence of

spermathecae is common to both species; on the other hand, the nephridiopores of this species are stated to open in front of the dorsal setae—a common position to find them in in this family, but different from that of *G. maximus;* there is no mention of the divergence of the setae posteriorly; this, however, might be regarded as of less importance for purposes of generic definition, since in one species of *Anteus* we meet with the same condition, which is not to be met with in other species. The male pores are said to be on the seventeenth segment; the sperm-sacs are extremely long, reaching back as far as to the fifty-seventh segment. The most remarkable statement, however, concerns the ovaries; these are placed by PERRIER in the eighteenth segment! The only other species in which the ovaries have been said to show this remarkable abnormality in position is *Rhinodrilus proboscideus* (see p. 642).

Genus SPARGANOPHILUS, BENHAM.

DEFINITION. Prostomium not marked off from buccal segment. Clitellum, XV–XXV. Male pores XVIII/XIX. No calciferous glands. Two pairs of sperm-sacs. Spermathecae in VII–IX. Sperm-duct runs in body-wall just below epidermis.

This genus has the distinction of being the only Rhinodrilid occurring in Great Britain; it was discovered by BENHAM in the year 1891 in the Thames. Like many aquatic worms it has no gizzard, and the nephridia are absent in the first few segments of the body; these organs commence in the thirteenth segment. The most remarkable character of the genus is the position of the sperm-duct just below the epidermis; this position is quite unique; in several worms these tubes lie in the thickness of the body-wall, but in no other do they lie so deep as in the present genus. The dorsal vessel is dilated in each of segments ix, x, xi; in segments ii–xi a pair of commissural vessels unite the dorsal and the ventral vessels; there is no supraintestinal vessel. Two lateral vessels arise on either side of the body, one from the dorsal integumental trunk, the other from the ventral integumental trunk in the fourteenth segment, and run as far as the anterior extremity of the body. Although the nephridia do not commence before the thirteenth segment, there are three pairs of 'salivary glands' in segments iv, v, vi; as these are said to have the same structure as the salivary glands of *Eminodrilus*, it seems probable that they are like the 'mucous glands' of *Pontoscolex*, &c., homologous with nephridia. There is but one species, viz.

Sparganophilus tamesis, Benham.

S. tamesis, Benham, Q. J. M. S., vol. xxxiv, 1893, p. 155.

Definition. *Length, three or four inches. Setae strictly paired, ornamented. Anus dorsal in position. Hab.—River Thames.*

The worm occurs in the Thames; it is said by Benham to be firm to the touch, and to wriggle violently when handled. The cocoon is rather elongated and sausage-shaped, somewhat as in *Criodrilus.*

Genus TRICHOCHAETA, Beddard.

Definition. Setae paired or scattered, ornamented at tip with numerous spinelets. Prostomium long and retractile. Calciferous glands small and rudimentary. Testes and sperm-ducts one pair. Sperm-sacs very long, with numerous short branches posteriorly.

This genus, which is exclusively West Indian in habitat, contains two species; both of these have been described by myself in two recent memoirs (**39**, **57**). The peculiar form of the setae absolutely distinguish the genus from any allied form; they have the usual *ſ*-shape, but at the free extremity the seta is covered by a great number of minute spinelets which give this part of the seta a roughened appearance; as the fine points of these spines are apt to get worn off, the rough appearance is sometimes alone left. In one species of the genus (*T. hesperidum*) the setae are as in *Pontoscolex* and *Diachaeta* scattered; in the other species (*T. barbadensis*) the setae are strictly paired throughout, showing no traces of the irregular arrangement; this fact might be regarded as a reason for separating the two species in question generically; the case of *Pontoscolex* seems to render this unnecessary; it will be remembered that in the species *P. corethrurus* there are individuals which have paired setae, though in the great majority of individuals the setae are, after the first few segments, irregular in disposition. The prostomium has a considerable length, and it is, as in the genus *Rhinodrilus,* retractile within the mouth-cavity. The clitellum is complete, at least in *T. barbadensis;* in the second species of the genus the clitellum is unknown; a complete clitellum is rare in the family Geoscolicidae; the only other instance is *P. trinitatis.*

The position of the apertures of the male pores is unusually far back in *T. hesperidum*—on the twenty-fourth segment.

The internal anatomy of this genus does not show many differences from that of the closely allied *Pontoscolex;* the characteristic calciferous glands of the latter are, however, apparently missing; I stated that they were absent in *T. hesperidum;* in the other species of the genus a microscopical examination has shown their presence, but in an extremely reduced condition; they are the smallest caeca, without any folding of the lining membrane; so small that in a dissection they would be completely invisible; hence, no doubt, my statement that they were absent in *T. hesperidum.* The genus has, as all Geoscolicidae have, a gizzard. The nephridia are paired, and the first pair are very much enlarged, as in *Pontoscolex* and other genera. The last pair of hearts are in the eleventh segment.

The reproductive organs are formed on a plan identical with that of other Geoscolicidae; there is but a single pair of testes, in the eleventh segment; opposite to these is a large pair of funnels, which extend through at least two segments in *T. barbadensis;* the sperm-sacs are a single pair in correspondence with the other male genitalia; they are peculiar in their extreme fineness, being at their commencement the merest threads; further back the calibre increases somewhat; but they are nowhere at all comparable to the sperm-sacs of other earthworms in breadth; they are as long as in *Diachaeta,* extending through forty or fifty segments; the hinder half of the sperm-sacs is provided with short diverticula—a unique feature. The spermathecae are three pairs, and are, as in all Geoscolicidae, without diverticula; they lie in segments vi, vii, viii, or ix, x, xi, the variation in position being paralleled by the two species of *Pontoscolex, P. corethrurus* and *P. trinitatis;* they open on to the posterior boundary of the segment which contains them.

(1) **Trichochaeta hesperidum,** Beddard.

T. hesperidum, Beddard, Q. J. M. S., vol. xxxiv, 1893, p. 252.

Definition. *Moderately large worms. Setae irregular from the first setigerous segment, the ventralmost seta, however, maintaining its position throughout. Sperm-duct pores on XXIV. Spermathecae in VI, VII, VIII. Six moderately thick septa behind gizzard. Hab.—Jamaica; Trinidad.*

This species is to be distinguished from the next by the irregular setae and by its greater size.

(2) **Trichochaeta barbadensis,** Beddard.

T. barbadensis, Beddard, P. Z. S., 1892, p. 701.

Definition. *Length,* 24 *mm.; number of segments,* 84. *Setae paired. Clitellum complete,*

occupying segments XIII–XXII. Rudimentary calciferous glands in VII, VIII, IX. Spermathecae in IX, X, XI. Hab.—Barbadoes.

This species has not the enormously elongated sperm-sacs of the last; at any rate, the single example examined by myself had not. They extended only through five or six segments. The funnels of the sperm-ducts are very large; they nearly reach the testes in front and end just in front of the septum bounding segments xiii/xiv; they lie within the sperm-sac. The oviducal pores lie in the groove between segments xiv/xv; in *T. hesperidum* these pores lie within the ventral pair of setae. The sperm-duct does not open so far back as in the latter species; it appears to open on to the seventeenth segment.

Genus ONYCHOCHAETA, BEDDARD.

Syn. **Diachaeta,** BEDDARD.

DEFINITION. **No prostomium. Setae absent on the first five segments, scattered from the commencement. Mucous gland present; calciferous glands represented by a swelling of the intestine with folded walls, occupying segments XIII–XIV. Two pairs of testes, ciliated rosettes and sperm-sacs.**

This genus is, at present, only known from a single species investigated by myself. The most remarkable character, which distinguishes the genus from its allies, *Pontoscolex* and *Diachaeta*, is the arrangement and structure of the setae. Their absence from the first few segments of the body is not a peculiarity of the genus; it is met with in the genera *Tykonus* and *Kynotus*. Nor is the fact that the setae are irregular in disposition unique; scattered setae characterize *Pontoscolex, Diachaeta,* and the little known genus *Geogenia;* moreover in *Diachaeta* we have this scattered condition apparent from the first segment which has setae, as in the present genus. What is chiefly remarkable about the setae of *Onychochaeta* is that they are not arranged—in the first three segments upon which they occur at any rate—in a regular transverse ring. They are in the segments referred to disposed in two distinct rings, a possibly commencing division of the segment into two. The setae are of two kinds as is usual in this family. There are simple sigmoid setae without any ornamentation, and longer and at the same time ornamented setae. As a general rule the ornamented setae, when present in addition to simple unornamented setae, are confined to the clitellum; this is, however, not the case with the genus *Onychochaeta*. On the first few segments of the body the setae are all of the larger ornamented kind. After the tenth segment these setae also occur,

but they are mingled with simple small unornamented setae. These latter gradually come to be the only ones present, and towards the end of the body their extremity gets to be more pronouncedly hooked. At the tail end the setae, while still preserving to some extent the character of the setae in the middle region of the body, are enormously enlarged; their extremity is very hooked, and possibly, as I have suggested, serves to hold fast the body of the worm in the ground.

The nephridia of this genus are, on the whole, similar to those of *Pontoscolex;* they agree in possessing a terminal sphincter at the point of opening on to the exterior.

Onychochaeta windlei, BEDDARD.

Diachaeta Windlei, BEDDARD, Q. J. M. S., vol. xxxi, 1890, p. 159.

O. Windlei, BEDDARD, P. R. Phys. Soc., 1890, p. 259.

Definition. *Length,* 100 *mm. Clitellum commencing at segment XV. Gizzard in VI. Two pairs of hearts in X, XI. Three pairs of spermathecae in VII, VIII, IX. Hab.—Bermudas.*

I have nothing to add to the above definition, as the principal characters have been already described under the genus.

Genus ILYOGENIA, BEDDARD.

DEFINITION. **Setae paired. Clitellum, XII–XIX. Male pores on XVII. Gizzard absent; calciferous glands, one pair in IX. Spermathecae, one pair in IX.**

This genus consists of only a single species, which, unlike any other member of the subfamily Geoscolicinae, inhabits Africa. It is evidently in some particulars in a degenerate condition as compared to other allied genera; this is shown not only by its small size, but by the fact that the nephridia do not terminate, as they usually do, in a muscular sac, but open directly on to the exterior without the intervention of such. They open, too, in front of the ventral pair of setae. From the eighth or ninth segment onwards the nephridia are invested by a thick sheath of clear non-staining pyriform cells. The presence of septal glands from the fourth to the seventh segments connected by a fibrous strand on each side of the body is another point of agreement with some of the lower Oligochaeta. The intestine begins in the twelfth segment. The calciferous glands of segment ix arise ventrally from the oesophagus and are of considerable size, though confined to their segment. The lumen of these glands is much subdivided by trabeculae. Both the supra-intestinal and subnervian vascular trunks appear to be absent; the last pair of hearts

is in segment xi. From the forwardly-directed apices of the calciferous glands arises on each side of the body a lateral longitudinal vascular trunk.

The sperm-sacs of this genus are very unusual in their arrangement, being quite unique in this family and rare elsewhere. They lie in segments ix and xii, the intervening segments being filled with sperm unenclosed in any membrane. The anterior pair of sacs—both are racemose in character—are attached to the hinder wall of their segment; the posterior pair to the front wall of the twelfth segment. The ovaries are joined across the middle line. MICHAELSEN (16) is of opinion that this worm is really an *Ocnerodrilus* in which the spermiducal glands have disappeared.

Ilyogenia africana, BEDDARD.

I. africana, BEDDARD, P. Z. S., 1892, p. 703.

Definition. *Length, about 1 in. Skin unpigmented. Septal glands in segments IV–VII. Intestine begins in XII. Hab.—Durban, Natal.*

Genus TYKONUS, MICHAELSEN.

Syn. **Anteus,** MICHAELSEN (in part.).

DEFINITION. **Setae on anterior segments defective. Clitellum, XIV (XV)–XXIV (XXVI). Male pore on XIX/XX, or XX. Sperm-sacs, one pair only.**

As already stated, I include in the genus one species referred by MICHAELSEN to the genus *Anteus*, as well as *Tykonus grandis*. The distinctive characters of the genus appear to me to be two. In the first place, the setae are defective upon the anterior segments, as in not a few other Geoscolicids; the actual segment upon which they commence differs in the different species, and very possibly varies in individuals. The spermiducal gland of *T. grandis* is peculiar to itself. These characters are, perhaps, sufficient to distinguish the species in question generically from each other. I admit that these American Geoscolicids cannot be considered yet to have found their permanent position in the system. All these species have but a single pair of sperm-sacs, which is the second distinctive character of the genus.

(1) Tykonus grandis, MICHAELSEN.

T. grandis, MICHAELSEN, Arch. f. Nat., 1892, p. 212.

Definition. *Length,* 300 *mm.; breadth,* 10 *mm.; number of segments,* 320. *Setae paired, ornamented; ventral setae begin with segment XIII, dorsal with XXVI. Nephridiopores,*

beginning on XIV, open in front of and a little above ventral setae. Clitellum, XV–XXVI. Male pore, XIX/XX, provided with a gland into which opens (?) sperm-duct. First septum separates segments VI/VII; this and those up to XI/XII thickened. Gizzard in VI; calciferous glands in XII; intestine begins about XV, with well-developed typhlosole. Last heart in XII. Hab.—Passofundo, Brazil.

The spermathecae seem to be absent; at least there is no mention of them.

(2) Tykonus appuni (Michaelsen).

Anteus Appuni, Michaelsen, ibid., p. 218.

Definition. *Length, 380 mm.; breadth, 10 mm.; number of segments, 136. Setae paired, ornamented; ventral setae begin about XV, dorsal about XXIV. Nephridiopores begin about XV and open in front of lateral setae. Clitellum, XV–XXIV. Male pores on XX. Septa, V/VI (the first)–VII/VIII, IX/X–XIII/XIV, thickened; VIII/IX absent. Gizzard in V; calciferous glands in IX. Spermathecae in VII and VIII, the posterior pair larger. Hab.—Puerto Cabello.*

This species is provided with a series of paired papillae on segments xvii–xix and xxi–xxiii.

Genus Anteus, Perrier.

Syn. **Hypogaeon**, Schmarda (in part.).

Definition. Setae paired, ornamented. Clitellum, XIII (XIV)–XXIII (XXXII). Nephridiopores in front of outer setae. Nephridia of anterior segments differing slightly in character from those of posterior segments. Calciferous glands two or three pairs. Sperm-sacs, two pairs in XI, XII. Spermathecae absent.

I have already discussed (p. 634) the differences which serve to separate the present genus from *Rhinodrilus*. The genus certainly contains two distinct species, and I am inclined to allow three. The two species, *Anteus gigas* and *A. heterostichon*, are plainly separable; if *A. gigas* has closely-approximated setae throughout the body[1], the species described by Horst (**6**) as *A. gigas* is not identical with the species so named by Perrier. For the former I have suggested the name of *A. horsti;* it serves to connect the two other species, for its setae become *slightly* separated from

[1] This is what Perrier says on the matter (3, p. 52): 'Les soies sont disposées, comme chez le lombric ordinaire, en quatre rangées de paires. . . Ces rangées sont constamment parallèles d'une extrémité à l'autre du corps, et les soies de chaque paire sont toujours très-rapprochées l'une de l'autre.'

each other behind, instead of widely, as in *A. heterostichon.* This separation of the setae posteriorly is a mark of affinity with *Geoscolex,* to which genus, however, *Anteus* shows no other strong affinities.

(1) **Anteus gigas,** PERRIER.

A. gigas, PERRIER, Nouv. Arch. Mus., 1872, p. 50.

Definition. *Length,* 1 *m.* 60 *cm. Setae strictly paired throughout the body, not ornamented* (?). *Clitellum, XIII–XXIX* (?). *Six specially thickened septa follow the gizzard. Nephridia change in structure in segment XX. Hab.—Cayenne.*

(2) **Anteus horsti,** BEDDARD.

A. gigas, HORST, Notes Leyd. Mus., xiii, 1891, p. 77.

A. Horsti, BEDDARD, Ann. and Mag. Nat. Hist., Feb. 1892, p. 117.

Definition. *Length,* 86 *cm. Colour* (*in spirit*) *bluish green, darker dorsally; clitellum brownish. Setae paired, becoming slightly separated from each other posteriorly, ornamented; clitellar setae longer, but with a similar though more marked ornamentation of ridges. Clitellum, XIV–XXXII. Gizzard followed by six strong septa; calciferous glands, three pairs. Hab.—Brazil.*

(3) **Anteus heterostichon** (SCHMARDA).

Hypogaeon heterostichon, SCHMARDA, Neue wirbell. Thiere, I, ii, 1861, p. 14.

A. heterostichon, BEDDARD, Ann. and Mag. Nat. Hist., Feb. 1892, p. 117.

Definition. *Length,* 250 *mm.; diameter,* 12 *mm. Colour* (*in spirit*) *yellowish white anteriorly, bluish posteriorly. Setae ornamented, those on clitellum with a more marked ornamentation and longer, paired anteriorly in eight series posteriorly. Nephridiopores in front of outermost setae of dorsal couple. Clitellum, XV–XXIII. Gizzard present in VI; calciferous glands in XII, XIII. Septa dividing segments VI/X thickened. Nephridia from segment XIII differ from anterior series in having a short caecum. Hab.—Ecuador and the Cordilleras.*

This species was originally described by SCHMARDA; the type-specimens have been lately examined by myself. There is no doubt that it belongs to the genus *Anteus,* though from SCHMARDA'S diagnosis it might have been supposed to be referable to *Geoscolex.* That diagnosis runs as follows:—

> 'Series setarum in dorso octo, binae in antice parte convergentes, in postice divergentes.'

Hypogaeon is a name which must be dropped as it is apparently synonymous with *Lumbricus* (*s. l.*).

In addition to the points mentioned in the definition of the species given above the following may be noted. The calciferous glands, like those of *Pontoscolex*, are completely detached, and stand out from the walls of the oesophagus; they are subconical in form, the apex being directed away from the gut. After the last thick septum there is one which is considerably thinner, but which is closely attached to those in front and covers them.

Genus PONTOSCOLEX, SCHMARDA.

Syn. **Lumbricus**, FR. MÜLLER (in part.).
Urochaeta, PERRIER.

DEFINITION. **Setae ornamented, bifid at the free extremity, alternate in posterior segments. Male pores XX/XXI. Posterior nephridia with glandular diverticula; peptonephridium present. Calciferous glands three pairs. Spermathecae, two or three pairs in front of testes.**

The first really adequate description of this genus is due to PERRIER (**5**); the memoir referred to contains an exceedingly elaborate account of the anatomy of '*Urochaeta*,' the section dealing with the organs of circulation being especially full and detailed; more recently HORST (**17**), ROSA (**1**), and I myself (**28, 45, 61, 71**), have contributed to the knowledge of the genus.

The generic name '*Urochaeta*' was first introduced by PERRIER (3), two years before his exhaustive memoir upon the genus appeared; at that time the French naturalist was unaware of the fact that this worm had been previously discovered and described by FRITZ MÜLLER as a species of *Lumbricus*. Though PERRIER was, of course, perfectly justified in creating a new genus for the '*Lumbricus corethrurus*' of MÜLLER, I showed myself (28) that in reality the name which ought to be applied is *Pontoscolex;* for a study of the type-specimens of *Pontoscolex arenicola* of SCHMARDA led to the conclusion that some of them must be referred to the same genus as *Urochaeta*. SCHMARDA'S diagnosis of the genus is as follows:—

'Quatuordecim series setarum alternas binas. Clitellum. Maricolae.'

From this almost useless definition hardly anything could be inferred as to the systematic position of *Pontoscolex*. And the rest of the information which SCHMARDA gives is not of much more use. ROSA, however (20), influenced, no doubt, by the 'quincuncial' arrangement of the setae, rightly referred *Pontoscolex* to his family Geoscolicidae. VAILLANT also, though declining to commit himself (6) as to the proper place in the system which the genus should occupy, called attention to its resemblances to *Urochaeta*.

This genus is one of the most widely distributed; its wide distribution is all the more remarkable from the fact that there are at most only three species known. Schmarda found it upon the sea-shore of the island of Jamaica, in company with *Diachaeta littoralis* and *Pontodrilus*. Müller recorded it from Brazil. Perrier's specimens came from Martinique, Gloria, Brazil, and, lastly, from Java. Horst and Rosa received the genus from Sumatra and from Nias. I have had examples from the following widely separated localities: British Guiana, Hawai, St. Vincent, Singapore, Australia, Andaman Islands. It is, therefore, characteristic of the tropics of both the Old and New Worlds, with the exception of Africa from which continent it has not yet been obtained.

The most salient external character of the genus *Pontoscolex* is the irregular disposition of the *setae* upon the posterior segments of the body; upon the first few segments the setae are regularly paired; but by gradual degrees the setae get further apart and do not correspond in successive segments; finally, on the segments at the hinder extreme of the body, the eight setae of each segment regularly alternate in position from segment to segment, producing the impression that there are more than eight setae *per* segment. These posterior setae are rather larger than those upon the head segments, but the difference in size is by no means so pronounced as it is in the genus *Onychochaeta*. The setae are, as is so frequently the case with the earthworms of the family Geoscolicidae, ornamented at the free extremity with transverse ribs; the clitellar setae are rather longer and straighter than the ordinary setae. *Pontoscolex* is unique among earthworms in having setae which are bifid at the free extremity, as in the Tubificidae and many other families of aquatic Oligochaeta.

The *clitellum* is saddle-shaped; it occupies segments xv–xxi (or thereabouts).

The *nephridiopores* are lateral in position; they do not, owing to their shifting in successive segments, always correspond to a seta.

There seem to be no *dorsal pores*.

The *alimentary canal* of *Pontoscolex* has a gizzard and three pairs of calciferous glands; the intestine has a typhlosole which occupies only the middle region; there are four specially thickened septa which separate segments vi/viii and x/xi, the intermediate septum being entirely absent.

A very distinctive feature of the genus *Pontoscolex* is the existence of peculiar sense organs, or rather bodies of unknown function in the epidermis; these were first discovered by Perrier, and are figured in his memoir upon '*Urochaeta*' already referred to. They are round, highly refracting corpuscles, furnished with a nucleus; they stain deeply with borax carmine, and are thus always very conspicuous in

transverse and longitudinal sections of the integument; PERRIER has figured these bodies as lying in involutions of the cuticle; they are, he thinks, of a glandular nature—are to be compared with the unicellular glands of the Articulata; VEJDOVSKY (**3**) has pointed out that there is a considerable similarity between these bodies and the large cells of the Enchytraeid *Anachaeta;* these latter occupy the position of the missing dorsal setae of that worm (see p. 354), and represent the seta follicles. This suggestion is certainly, on the whole, borne out by the appearance of the cells in question, in *Pontoscolex*, and also supports my contention that worms with few setae in each segment have been derived from a *Perichaeta*-like form; that the integumental bodies of *Pontoscolex* do not always form a regular row between the setae does not so far weaken that view of the homologies of the bodies; for in *Perichaeta* the setae occasionally form slightly irregular rows. My comparison (**62**) of the integumental bodies of *Pontoscolex* to the epidermic sense organs of the Eudrilidae no longer commends itself to me.

The *vascular system* of this worm is beautifully illustrated in PERRIER'S memoir; some of these figures are repeated in the present monograph (woodcuts, figs. 20 and 21).

In this place I shall only mention the principal features of the circulatory system which are of systematic importance; for further details the reader is referred to the account of the vascular system of the Oligochaeta on p. 64 et seq. The dorsal vessel communicates with the ventral vessel by three vessels in the eighth, ninth, and tenth segments; in the two following segments are two pairs of very much dilated 'intestinal hearts,' which put the supra-intestinal trunk into communication with the ventral vessel. Behind this segment there are no branches uniting the dorsal with the ventral vessel; but there are slender twigs which join the dorsal to the subneural vessel; anteriorly there are a pair of lateral vessels.

The *nephridia* consist of a series of paired tubes, as in all other Geoscolicidae. In the anterior part of the body one of these pairs is very much larger than those which follow; it was termed by PERRIER the 'Glande a mucosité.' The structure of this first pair of nephridia was imperfectly described by PERRIER; I subsequently added a few details upon its minute anatomy, showing conclusively that the gland is a nephridium (**71**). In many earthworms the anterior nephridia are thus enlarged and are occasionally connected with the buccal cavity. In *Pontoscolex*, however, the nephridium opens on to the exterior upon the second segment of the body; the anterior extremity of the body is so retractile that the aperture sometimes comes to lie within a temporary buccal cavity. A long muscular duct connects the external pore with a tuft of tubes lying closely pressed against the oesophagus on either side; these open into the body cavity by two or three funnels on each side. It is possible

that this large anterior nephridium is really due to the fusion of two or three embryonic nephridia (see p. 50). In the following segments the nephridia have also a well-marked muscular duct, which is furnished at the end (and this applies also to the first pair) within a rosette-shaped organ, which appears to be a gland; these cup-like bodies also occur in *Onychochaeta*. The nephridia commence in the fourth segment; the first few pairs have a larger funnel than the following nephridia, and in this agree with the 'mucous gland.'

In the last fifty segments or so of the body the nephridia are provided with a peculiar glandular caecum. This was described by PERRIER as opening separately from the nephridium; but I gave reasons (**61**) for believing it to be a glandular appendix of the nephridium. Similar structures occur in other genera of Geoscolicidae.

The *reproductive organs* of this genus conform to the type met with in other Geoscolicidae. There are, however, only a single pair of testes; these lie in rather an unusual position, in the twelfth segment; it is not by any means an easy matter to map the segments of the body in the anterior region; the septa following the four specially thickened septa which separate the segments immediately following upon that which contains the gizzard, are very thin and are pushed back in the middle, as is so often the case with earthworms; the position of a given organ is, therefore, difficult to ascertain; in any case, the ovaries lie in the segment directly following that which contains the testes; and we know that the position of the ovaries is much more fixed than that of many other organs; it is, therefore, more likely on the whole that the testes are abnormal in position than the ovaries. I place the testes, therefore, in segment xii. The sperm-sacs are a single pair of long 'tongue-shaped' bodies extending through a number of segments. Although there appear to be only a single pair of sperm-sacs that are developed from two pairs of outgrowths of the septa separating segments xi/xii, xii/xiii. Into the twelfth segment opens also the two funnels of the sperm-ducts; these are large and folded; the sperm-duct of each side passes along the body-wall to its external opening, quite unprovided with any trace of a gland, on the border-line between segments xx/xxi. The ovaries and the oviducts are so like those of other earthworms that they call for no special description; there are three, or sometimes (*P. arenicola*) two pairs of spermathecae; these organs are simple elongated pouches, lying in segments vi, vii, viii, and without any trace of diverticula.

A remarkable fact in the structure of this genus, also found in *Diachaeta*, is the swollen portion of the body near to the posterior extremity. This is figured by SCHMARDA in *P. arenicola* as the clitellum. In *P. corethrurus* FRITZ MÜLLER noted the same modified region of the body, which he described as being of a swollen

glandular appearance, red in colour and without setae, suggesting that it was the point at which new segments were formed. Perrier, in his account of the anatomy of this species, saw the same swelling upon the body, which was, in his specimens, nearly constant; he found that its commencement coincided with the termination of the typhlosole. I myself examined the same region by means of sections, and confirmed the idea of Müller; I found, however, that the setae are not universally absent, but that they are rare, and, when present, are of small size, suggesting embryonic setae; the epidermis too is without the glandular cells found elsewhere, another character suggesting an embryonic condition; the intestine lying in these three or four segments was narrower than elsewhere, and was found to be devoid of contents. This interesting subject has been recently more fully dealt with by Horst (**17**). In addition to confirming the facts described by his predecessors, the caudal zone was stated to be remarkable on account of the large development of blood-vessels. Horst has justly pointed out that there is, after all, not much in favour of regarding this tract as a zone of growth, which, indeed, as Perrier said, would be, if it existed, an entirely exceptional state of affairs. The nephridia show no signs of an embryonic state, nor do the septa or the nerve-chord. Horst, therefore, while unable to offer any suggestion of his own, declines to accept the view of Müller and myself. I am now inclined to adopt a modification of those views; it seems to me possible that this region of the body is still a zone of growth, as any part of the body is when by an accident it becomes the end of the body; the tail of a worm will, as we know, regenerate when it has been torn off; it is quite common to meet with worms with the end of the body of much less calibre than the rest, which shows that this part has been recently renewed after an accident. The rich blood-supply, and the, to some extent, embryonic character of the epidermis in the caudal zone, would possibly favour rapid regeneration; while the swollen character of this part of the body might very easily bring it about that the tail-end of the body, the part lying behind it, would be readily detached; perhaps it would more probably be broken in the middle; in this event, the regeneration would, ex hypothesi, be more rapid than if the body were broken elsewhere. On this view the structure in question is analogous to the foot of certain Mollusca, to the structure of the backbone in certain reptiles, which readily break at a certain point, allowing the animal to escape. It seems, however, that the mechanism is rather more perfect in the worm than in the other animals; not only is breakage facilitated, but there exists the power of a more rapid reconstruction of the injured part. This, however, must obviously remain for the present no more than a suggestion.

(1) **Pontoscolex corethrurus** (F. Müller).

Lumbricus corethrurus, Fritz Müller, Arch. f. Nat., 1857, p. 113.
Urochaeta hystrix, Perrier, Nouv. Arch. d. Mus., 1872, p. 142.
U. sp., Beddard, Proc. R. Soc. Ed., vol. xiv, 1887, p. 160.
U. corethrura, Beddard, Q. J. M. S., vol. xxix, 1889, p. 235.
U. dubia, Horst, Midden Sumatra iv, Zoologie xii, Vermes, p. 7.
P. corethrurus, Horst, Zool. Ergebn. Ost-Ind., Bd. ii, p. 51.

Definition. *Length, 60 mm.; diameter, 4 mm.; number of segments, 220. Setae bifid at extremity, slightly ornamented; clitellar setae with a more marked ornamentation; paired in anterior (ten to twelve) segments, displaced and irregular later. Clitellum, XIV (XV, XVI)-XXI (XXIII), saddle-shaped. Prostomium absent (?). Dorsal vessel single; hearts in XI, XII. Calciferous glands in VII, VIII, IX. Spermathecae in VI, VII, VIII. Hab.—Java; Sumatra; Queensland; Burmah; Brazil; British Guiana; Mauritius; W. Indies; Singapore.*

This species is one of the most widely spread, and one of the most abundant of exotic earthworms. It may be that there are varietal or even specific differences between individuals coming from such widely distant localities, as for instance, Australia and Brazil. In the meantime these differences have still to be put on record. The Australian (Queensland) specimens at one time appeared to me to differ. I can now detect no difference except perhaps that they are rather larger. Horst (**17**) accepts Rosa's identification of his *Urochaeta dubia* with the type-species.

The setae show some variation as to the segment in which a displacement commences. I found (in two specimens from Australia) that on the first eight segments the setae were distinctly and strictly paired. On the tenth segment (ninth setigerous) the ventral setae became separated; on the following segment the dorsal setae also. Horst found (in specimens from Java and Sumatra) that the setae of the ventral pairs begin to diverge in the eleventh segment, those of the dorsal couple in xii; behind the clitellum the setae begin to alternate, the dorsal ones first. Horst first put on record the fact that the setae are ornamented at the free extremity, they having been previously described as smooth, except, of course, the modified setae of the clitellum. This ornamentation is but faintly marked (as is also shown by the fact that other observers have not commented upon it) as compared with *P. hawaiensis*. In one out of a large number of specimens from

British Guiana, I found the setae to be paired throughout the body; FRITZ MÜLLER has noted the occasional occurrence of species with wholly paired setae.

The clitellum is another structure which varies in extent, as indicated in the description of the species; in one individual (from British Guiana) I observed a clitellum of only four segments (xviii–xxi). The clitellum is saddle-shaped, but the width of the ventral bare tract is apt to vary in different parts of the clitellum; on segments xvi–xviii of the clitellum in two individuals from British Guiana the bare space was extremely narrow widening gradually on the last; on segments xix–xxiii it was the double of its former width. The clitellum is orange coloured in the living worm, the rest of the body reddish, owing to absence of pigment.

The nephridiopores commence on the fourth segment; those of the 'mucous glands' open on ii. It has generally been stated that this species has no prostomium. MÜLLER, on the contrary, asserted the existence of one, and HORST has figured (**17**, Pl. iii, fig. 33) and described something very like a prostomium; the worm has the habit of inverting the first segment which conceals the prostomium.

(2) Pontoscolex arenicola, SCHMARDA.

P. arenicola, SCHMARDA, Neue wirbell. Thiere, I. ii, 1861, p. 11 (in part.).

Definition. *Anterior setae as well as those upon the clitellum ornamented; two pairs of spermathecae dilated at extremity into a reniform pouch.—Hab. Jamaica; sea-shore.*

Under the name of *P. arenicola*, SCHMARDA confounded no less than three distinct species of earthworms, all of which were found upon the sea-shore on the island of Jamaica; one of these is the present species, the other is a *Diachaeta*—*D. littoralis* (see p. 663), the third a *Pontodrilus*, which I cannot distinguish from *P. bermudensis*. *P. arenicola* does not show many points of difference from *P. corethrura;* the principal differences are mentioned in the diagnosis; the setae have the same irregular arrangement posteriorly; anteriorly they are paired; and at the hinder end of the body they have a regular quincuncial disposition; in *P. corethrura* the setae upon the clitellum are ornamented, the other setae having mere traces of the transverse ridges which are found upon the clitellar setae. In the present species the setae in front of the clitellum are also ornamented in the same way as are the clitellar setae, only differing from them in their greater size; I did not detect a bifid extremity; but this is often hard to detect in *P. corethrura*.

SCHMARDA has mentioned that the alimentary canal is furnished with '4 braune birnförmige Organe'; these I take to be the calciferous glands, which are, however,

present to the number of three pairs only, as in the other species of the genus. The spermathecae differ from those of the species *P. corethrura* in their number (there are only two pairs instead of three) and in their form; in the present species the spermathecae consist of a reniform pouch communicating with the exterior by a very long and narrow duct. The clitellum occupies segments xv–xxii, as in *P. corethrura;* in other points the two species appear to agree.

(3) Pontoscolex hawaiensis, NEW SPECIES.

Definition. *Length,* 142 *mm.; diameter (at clitellum),* 4 *mm.; number of segments over* 210. *Caudal zone at the end of second third of body. Setae paired at first, irregular afterwards; ornamented with ridges on free extremity. Clitellum, XIII–XXII. Dorsal vessel double, the two vessels fusing at the septa. Hab.—Hawaii, Mauna Loa (collected by Mr. Perkins).*

This species seems to be undoubtedly distinguishable from *P. corethrurus.* I have had the opportunity of examining eight or ten specimens all from the same locality. The caudal zone, as in *P. corethrurus,* appears to be constant in position; this is shown by the following measurements of two individuals selected at random:—

	A	B
Length of body in front of caudal zone . . .	90	80
„ „ behind „ „ . . .	47	40

The setae of this species have a much more marked ornamentation than in the last, and their arrangement is a little different. On the clitellum, and for a few segments behind it, the ventral setae are regularly paired, though each seta is further away from its fellow than in front. On the other hand, the lateral pair of setae are irregular on the clitellum; this, however, only applies to the outermost seta; seta three, to which corresponds the nephridiopore, has a fixed position.

The dorsal vessel in front of and for a little while after it emerges from the last thick septum is moderately thin; it gradually becomes thicker and at the same time moniliform; the increased thickness is due to the fact that it is double; its character is like that of the dorsal vessel of *Acanthodrilus novae-zelandiae:* that is to say, it is single where it traverses the septa. In the fourteenth and fifteenth segments the dorsal vessel attains to its greatest bulk; after this its calibre becomes suddenly diminished; it retains, however, its double character. In one out of three specimens dissected the dorsal vessel seemed to be single. The hearts are in xi and xii, and appear to be only connected with the supra-intestinal vessel. I found the sperm-sacs,

which are long and thin like those of the other species, often absent in specimens with a fully developed clitellum. In other characters the present species appears to agree with *P. corethrurus*.

Genus **UROBENUS**, BENHAM.

Syn. **Anteus**, MICHAELSEN (in part.).

DEFINITION. Prostomium present. Clitellum, XIV (XV)–XXIV (XXV). Setae paired, ornamented only on clitellum and some adjacent segments. A pair of caeca like those of *Perichaeta* present in segment XXVI. Sperm-sacs two pairs in XII–XIV (XVI). Three pairs of spermathecae in VII–IX.

We are at present acquainted with three species of this genus. It was originally described by BENHAM (**3**), and recently MICHAELSEN (**10**) and UDE (**4**) have added a second and a third species, which, however, were referred to the genus *Anteus*. I have already expressed the opinion that these two genera are quite distinct.

The most noteworthy character of this genus—one which serves to remove it from any other Geoscolicid—is the existence of two caeca apparently precisely similar to those of *Perichaeta*. These caeca also, it will be observed, occupy the same segment that their homologues do in *Perichaeta*, which adds, of course, to the similarity. The gizzard is, according to BENHAM, in segment viii; MICHAELSEN, on the other hand, places it in segments ix, x. It is possible that this apparent difference is merely brought about by the pushing back of the septa. In *Urobenus brasiliensis* there are calciferous glands; in the second species these glands are not described, but it is stated that the alimentary canal resembles that of the former.

Urobenus resembles *Perichaeta* in having the caeca upon the intestine; it resembles quite another genus—viz. *Pontoscolex*—in having a series of pyriform sacs in the posterior segments of the body. These sacs, however, are not as they are in *Pontoscolex* diverticula of the nephridia, but are independent structures opening separately on to the exterior. The existence of these pyriform vesicles is another reason for regarding this genus as distinct from *Anteus*, though it is not stated by MICHAELSEN whether they are or are not present in *U. papillata*.

(1) **Urobenus brasiliensis**, BENHAM.

U. brasiliensis, BENHAM, Q. J. M. S., vol. xxvii, 1887, p. 82.

Definition. *Length*, 150 *mm.; diameter*, $\frac{1}{3}$ *in.; number of segments*, 92. *Setae of clitellum*

have the imbedded portion more curved, otherwise not modified. Clitellum, XIV–XXV. Male pore on XX. Gizzard in VIII; calciferous glands in IX, X, XI. Hearts in XII, XIII. Sperm-sacs in XII (and XIII), XIV. Hab.—Pedça Açu, Brazil.

The calciferous glands of this species appear to have rather a remarkable form. They are described as being 'a reddish, ovoid body, opening into the intestine by means of a short, narrow stalk, and constricted near its free extremity in such a way that this portion has the appearance of a short cone, inverted on the end of the ovoid portion.' The intestine begins in xvi, and is at first deeply constricted by septa; in segment xxvi, after a particularly deep constriction, the sacculated intestine begins, which has a typhlosole. The nephridia commence in iii. The seven anterior pairs differ from the rest in having a larger vesicle, near to the free extremity of which the tube opens.

(2) Urobenus papillifer (MICHAELSEN).

Anteus papillifer, MICHAELSEN, Arch. f. Nat., 1892, p. 214.

Definition. *Length,* 122 *mm.; diameter,* 5–6 *mm.; number of segments,* 130. *Setae commence on segment III; those of clitellum ornamented. Clitellum extends from XV–XXV. Tubercula pubertatis forming a ridge on either side of segments XIX–XXIII. Male pore, XIX/XX. Gizzard in IX, X. Hab.—Porto Alegre.*

This species has, as its specific name implies, numerous papillae, which are very variable in position. The modified setae of the clitellum protrude from their apices. In one specimen there were four pairs on x–xvi, and an additional one corresponding to lateral setae of x; in another they were developed on x (two pairs) xvi, xvii, xxiv; in a third there were ventral papillae on x, xi, xv, and lateral on x. The sperm-sacs have, according to MICHAELSEN'S account, a very abnormal position; he describes them as being in segments xiii–xvi (with a query however).

(3) Urobenus teres (UDE).

Anteus teres, UDE, Z. wiss. Zool., 1893, p. 59.

Definition. *Length,* 90 *mm.; diameter,* 5 *mm.; number of segments,* 100. *Setae commence in III; those of ventral pairs of clitellum ornamented. Clitellum, XV–XXV. Male pores XIX/XX. Gizzard in IX, X; calciferous glands in XI. Hab.—Taquara, Rio Grande do Sul.*

A remarkable peculiarity of this species is the backward position of the sperm-sacs; there are two pairs lying in segments xiii–xv.

Genus DIACHAETA, BENHAM.

Syn. **Pontoscolex,** SCHMARDA (in part.).

DEFINITION. **Prostomium absent; setae irregular from the first. Mucous gland present. Calciferous glands absent. Sperm-sacs very long. Spermathecae two or three pairs. Testes and funnels, one pair.**

This genus is very near to *Pontoscolex* and to *Onychochaeta*. It differs from the former chiefly in the facts that the setae are irregular from the first, and that there are no glands connected with the posterior nephridia. Our knowledge of the genus is chiefly derived from BENHAM'S description of *D. thomasii;* my own notes upon a second species are not so full. I found, however, that the setae are occasionally bifid, a point not referred to by BENHAM; this brings the genus into somewhat nearer proximity to *Pontoscolex,* as does also the fact that the end of the nephridia is surrounded by the cup-shaped body so characteristic of *Pontoscolex.* As will be seen in the following lines, there is no possibility of confusing the two species of the genus.

(1) Diachaeta thomasii, BENHAM.

D. Thomasii, BENHAM, Q. J. M. S., vol. xxvii, 1887, p. 89.

Definition. *Length, about* 3 *inches; diameter, about* $\frac{1}{8}$ *inch; number of segments,* 335. *Clitellum, XX–XXXIII, complete. Septa VI/XI very much thickened. Gizzard in VI; intestine begins in XI. Last heart in XI. Sperm-sacs extend from XII–XXXVIII, constricted at the septa. Spermathecae in VI, VII, VIII. Hab.—St. Thomas, W. I.*

The specimens examined by BENHAM were so much contracted that the above measurements are probably incorrect.

(2) Diachaeta littoralis, BEDDARD.

Pontoscolex arenicola, SCHMARDA, Neue wirbell. Thiere, I, ii, 1861, p. 2 (in part.).
D. littoralis, BEDDARD, Ann. and Mag. Nat. Hist., Feb. 1892, p. 128.

Definition. *Length,* 3 *or* 4 *inches. Setae not ornamented, but bifid; clitellar setae longer and ornamented. Clitellum, XVI–XXXI. Spermathecae, two pairs. Hab.—Jamaica; sea-shore.*

This species is much nearer to *Pontoscolex* than the last, and, indeed, was confounded by Schmarda with *P. arenicola.* It is, perhaps, doubtful whether it ought not to be referred to that genus rather than to *Diachaeta.* The gizzard and the thickened integumental septa are exactly as in *P. arenicola;* I think also, but am not quite certain, that the caudal zone was present. The clitellum is further forward than in *D. thomasii,* and is thus nearer to that of *Pontoscolex.*

Subfamily Microchaetinae.

Definition. **Spermathecae (if present) usually in neighbourhood of the female apertures, nearly always minute, and generally many in each segment. Copulatory papillae, furnished with special glands, and usually with modified setae, present.**

This subfamily is absolutely confined to the Old World, occurring in Africa, Burmah, Madagascar, and some of the East Indies, and in Europe.

I refer the eight genera, whose chief characters are exhibited in the annexed table, to this subfamily; all of these genera, however, cannot, as yet, be regarded as established beyond a doubt; of *Bilimba* we have at present too little knowledge to assert that it is not synonymous with *Callidrilus.* The other genera are perhaps distinct; Benham has expressed the opinion that *Kynotus* is a near ally of *Microchaeta,* if not congeneric with it; there is no doubt that he is right in pointing out that the species of *Microchaeta, M. belli* and *M. papillata,* form a link between the two; for these two species, like the genus *Kynotus,* possess copulatory glands which are furnished with modified setae. *Microchaeta,* however, differs in having no terminal glands into which the sperm-ducts open, in possessing one pair of calciferous glands, and in a few other minor characters.

The four genera, *Callidrilus, Bilimba, Annadrilus,* and *Glyphidrilus,* seem to form a natural assemblage in the fact that the setae are not deficient anteriorly, and that the two setae of each pair are separated by a comparatively wide interval anteriorly, while they are strictly paired posteriorly; in other important points, such as the presence or absence of a spermiducal gland, the existence or non-existence of copulatory glands they disagree.

Siphonogaster holds an isolated position; and yet it is not so different as a study of its structure might at first seem to show; the most salient point of difference, not only from other Microchaetidae, but from the Geoscolicidae in general, is the existence of the two non-retractile penes; these are outgrowths of the body-wall, and it will be noticed that they possess modified setae and glands, such as are

present upon the body-wall of other genera; the difference is that the region of the body upon which the copulatory glands and setae are developed is drawn out into the two penes.

Brachydrilus, though peculiar in possessing two pairs of nephridia in each segment, agrees with *Microchaeta* perhaps more closely than it does with any other genus; it is the only other member of this subfamily which has a pair of calciferous glands, and it has apparently a series of glands without modified setae attached, such as are found in *Microchaeta benhami.*

	SETAE.	♂ PORES.	CLITELLUM.	NEPHRIDIA.	CALCIFEROUS GLANDS.	GIZZARD.	LOCALITY.
Kynotus . .	defective on a variable number of anterior segments	xv or xvii	xix–xxv	begin in ii	o	v or vi	Madagascar
Microchaeta .	defective on first few (i–vi) segments	xx or xx/xxi	xi (xiii)–xxiii (xxviii)	,,	ix or x	vi or vii	S. Africa
Callidrilus . .	setae more distant anteriorly than posteriorly	xvii	xv–xxiv			v–vi	E. Africa
Bilimba . .	more distant anteriorly than posteriorly					many	Burmah
Glyphidrilus .	,, ,,	xxvii/xxviii	xxii–xxxii	defective in first fourteen segments	o	viii	Java, Sumatra
Annadrilus .	more distant anteriorly	xxi/xxii	xix–xxv	defective in twelve anterior segments	o	,,	Sumatra
Siphonogaster .	paired	eighteen on penes	?		o	o	E. and W. Africa
Brachydrilus .	,,	xviii	xvi–xxi	two pairs in each segment	viii		?
Criodrilus . .	,,	xv	xvi–l	defective in first nine segments	o	o	Europe
Hormogaster .	dorsal setae paired, ventral far apart	xv/xvi	xv–xxv	begin in iii	o	three in vi–viii	,,

I place *Hormogaster* in this subfamily not without misgivings; its relation to other Geoscolicidae have been already dealt with.

Genus CRIODRILUS, HOFFMEISTER.

DEFINITION. Setae paired, ornamented. Clitellum, XIV–XLV (?). Male pores on XV. Anus dorsal in position. Gizzard and calciferous glands absent. Nephridia commence in X. No dorsal pores. Spermathecae absent. No spermiducal or copulatory glands.

This genus has been hitherto invariably placed in the family Lumbricidae—a situation which is not, in my opinion, at all justified by its anatomical structure. Rosa remarks of the genus that it is 'in fondo un' *Allolobophora* modificata e in parte degenerata in seguito a perfetto adattamento alla vita acquatica'—a statement which is almost word for word that of Benham.

Its resemblances to *Allolobophora* are the following:—

(1) Presence of spermatophores.

(2) Male pores on xv, surrounded by swollen lips.

(3) Sperm-sacs and sperm-ducts.

Of these only the first is of any importance; the second has lost the importance which it once had owing to the discovery of a *Kynotus* with male genital pores opening upon this segment.

That the sperm-sacs are like those of *Allolobophora* is not a matter of first-rate importance.

As to the presence of spermatophores—they are undoubtedly unknown elsewhere than in *Allolobophora* and *Lumbricus* with the peculiar form that characterizes them in *Criodrilus*. Spermatophores, as I have pointed out, do exist in *Benhamia* and *Polytoreutus*. It is quite likely that they will be found elsewhere.

The principal reason which leads me to refer the genus to the family Geoscolicidae is the extensive clitellum; in no *Lumbricus* or *Allolobophora* does the clitellum begin so far forward and extend so far backwards; on the contrary, a clitellum of this kind is perfectly characteristic of the Geoscolicidae, though it is undoubtedly extensive even for that family.

Other facts in the structure of *Criodrilus* are not opposed to its inclusion in the present family. It has been pointed out that the absence of spermathecae is a point of resemblance to *Allolobophora eiseni* and *A. constricta;* but there are Geoscolicids (*Anteus, Siphonogaster*) in which these organs are not present.

The ornamentation of the setae in *Criodrilus* seems to be rather doubtful. It is figured by Vejdovsky (**24**), but not by either Rosa or Oerley. Collin (**1**) does not refer to it.

If characteristic, the ornamentation of the setae with transverse ridges is a marked point of resemblance between *Criodrilus* and the Geoscolicidae.

Our knowledge of the cocoons of earthworms is not very extensive; so that it is premature to base any affinities upon the few facts that we do know. I call attention, however, as bearing on the matter in hand, to the peculiar form of the cocoon in *Criodrilus;* it is very long, of comparatively small diameter, and is drawn out at both ends. The only other worm which has a cocoon anything at all like

this in shape is the Geoscolicid *Sparganophilus*. A more detailed description of these cocoons will be found on p. 147.

There is only one well-characterized species in this genus, viz. *C. lacuum*. OERLEY has described another under the name of *C. dubiosus*. Judging from his figures of this species (**3**, Pl. iii, fig. 9)—the text is in Magyar—the main difference concerns the form of the prostomium, which is not so long as in *C. lacuum*, the body, too, does not seem to be quadrangular in shape posteriorly. ROSA says nothing about the species in his recent 'Revisione dei Lumbricidi.'

Criodrilus lacuum, HOFFMEISTER.

C. lacuum, HOFFMEISTER, Die bis jetzt bek. Art. Regenw., 1845, p. 41.

Definition. *Length,* 300 *mm.; diameter,* 6 *mm.; number of segments,* 400. *Colour olive inclining to red and green, yellow below. Setae strictly paired. Prostomium not very distinct from buccal segment, without a posterior process. Clitellum, XVI–L. Hab.—Germany; Italy.*

This species has been fully described, studied and illustrated by VEJDOVSKY (**24**), BENHAM (**4**), OERLEY (**4**), COLLIN (**1**), and ROSA (**12**). HATSCHEK, BERGH (**4**), and VEJDOVSKY (**15**) have treated of its development.

Genus **MICROCHAETA**, PERRIER.

Syn. **Lumbricus**, AUCT. (in part.).
Antaeus, VAILLANT (in part.).

DEFINITION. Setae paired, rarely ornamented, sometimes absent from first few segments. Spermathecae often numerous in each segment, placed in neighbourhood of gonads. Accessory glands with copulatory setae occasionally present.

This genus was originally described by RAPP, who, however, regarded it as a species of '*Lumbricus*'; it was subsequently investigated by myself (**7**), and, almost at the same time, by BENHAM (**2**); later, BENHAM (**3**) recorded a new species of the genus, and, later still (**8**), two additional species; ROSA (**8**) has described a fifth species.

The segmentation of the body is a little obscure, and has led to mistakes in the location of various organs; this has resulted from the fact that the setae are very small and difficult to see, and that the segments are much annulated. Hence the limitation of the segments has been a matter of difficulty. In the various

species of the genus there are several modifications of the first two or three segments; in *M. belli* the anterior segments are quite plain, and the setae commence, as usual, on the second segment; in *M. beddardi* the first two segments are not at all distinctly separated, and the same is the case with the type-species of the genus, *M. rappi;* for this reason in both of these the setae appear to lie on the first segment of the body; in *M. papillata* the first seta-bearing segment is the third; in *M. benhami*, ROSA was unable to find setae upon any of the first five segments. In *M. belli* and *M. papillata* the setae are ornamented as in *Rhinodrilus.* The clitellum is extensive, but varies in extent in different species.

The internal anatomy of the genus is fairly well known, and, as regards all the described species; a gizzard is universally present; so is a pair of calciferous glands; these latter, in *M. rappi*, present the appearance of a highly vascular swelling of the oesophagus in the tenth segment; this same segment (the tenth) contains a pair of glands in the two species *M. benhami* and *M. papillata;* in *M. beddardi* and *M. belli* the calciferous glands, although still a single pair, are partly in the tenth, and partly in the ninth segment, being nipped by the septum dividing these two segments.

The generative organs are constructed upon the same plan as are those of the allied *Kynotus;* the testes, however, and the corresponding sperm-duct funnels are single in *M. beddardi* and *M. belli;* the orifice of the sperm-ducts is situated far back in those species where it has been found; in *M. rappi* in the twentieth segment, in *M. benhami* between segments xx and xxi. As in *Kynotus* and other genera of Old-World Geoscolicidae there are peculiar accessory copulatory organs placed in the neighbourhood of the male pores; these only exist, as far as the present genus is concerned, in *M. papillata*, *M. belli*, and *M. benhami;* they have been described by BENHAM in *M. papillata,* and by ROSA in *M. benhami.* According to BENHAM, these structures lie in *M. papillata*, on segments x and xxv; they correspond in position to the ventral setae. Each papilla is represented internally by a kidney-shaped gland attached to the parietes by a band of muscular fibres serving as a retractor of a sac of modified setae; the kidney-shaped body is lined by epithelium, outside of which is a layer of muscles; outside this again is a mass of cellular tissue, consisting of pyriform cells associated into bundles; the structure of the organ, in fact, bears the closest resemblance to the spermiducal glands of *Moniligaster*, only that, in the present case, the whole is surrounded by a layer of peritoneum, sometimes, apparently, wanting in *Moniligaster.* In *M. benhami* there are eighteen pairs of similar sacs in segments xi–xxviii; their structure appears to be identical with that of the glands just described; but nothing is said as to the presence of copulatory setae in connexion with them. In neither species is there any connexion between the

sperm-ducts and the glands, such as occurs in the allied genera *Kynotus* and *Callidrilus;* or, rather we should say, without prejudicing the question as to the homologies of the glands in question, that in *Microchaeta* the sperm-ducts open directly on to the exterior, not through any glands whatsoever.

Another matter in which the present genus resembles the majority of the Old-World Geoscolicidae is in the form and position of the spermathecae. They are invariably placed far back, in the neighbourhood of the testes and ovaries; in *M. rappi* there are a number of minute oval pouches in segments xiii, xiv, xv, xvi; the average number appears to be three of these on each side, but there is considerable variation. In *M. papillata* there are altogether ten or twelve pairs, on either side of the body in segments xiii, xiv; in *M. belli* there are fewer—eight altogether—in segments xii, xiii.

The reduction in the number of the spermathecae has progressed still further in *M. beddardi;* in this species there are only four altogether, two in each of segments xii and xiii [1]; finally, in *M. benhami* there are six pairs, one in each of segments xi–xvi.

The five species of the genus *Microchaeta* are, with the exception of *M. benhami,* whose locality is unknown, African. Their principal characters are noted in the accompanying table.

	SETAE.	CLITELLUM.	DORSAL VESSEL.	CALCIFEROUS GLANDS.	COPULATORY GLANDS.	TESTES.	SPERMATHECAE.
M. rappi . .	begin in ii	xiii–xxvi	double in v–ix	x	o	two pairs	one to four pairs in xiii–xvi
M. beddardi .	,,	xi–xxiii	double in vii–ix	ix/x	o	one pair	paired in xii–xiii
M. belli . .	,,	xiii–xxi	,,	,,	xiii	,,	two pairs in xii–xiii
M. benhami .	begin in vi	xiv–xxvii	single	x	xi–xxviii	two pairs	paired in xi–xvi
M. papillata .	begin in iii	?	double in v–ix	,,	x and xxiii	,,	five or six pairs in xiii, xiv

(1) Microchaeta rappi, BEDDARD.

Lumbricus microchaetus, RAPP, Jahresheft Ver. f. vaterl. Nat. Würtemberg, 1848, p. 142.

M. rappi, BEDDARD, Trans. Zool. Soc., vol. xii, 1886, p. 63.

Antaeus microchaetus, VAILLANT, Annelés, p. 185.

[1] See footnote to p. 672.

Definition. *Length, 3 feet, 6 inches. Clitellum, XIII–XXVI (about). Calciferous glands in X. Testes two pairs. Spermathecae in segments XIII–XVI, one to four pairs in each. Hab.—Cape Colony.*

This is one of the few species of exotic Terricolae concerning which there is already a considerable literature. The first describer of the worm was Rapp, whose description, written as it was in 1848, is naturally very imperfect; it is, indeed, practically confined to certain external characters, though Vaillant with quite unnecessary approbation speaks of Rapp's paper as being 'très complète pour l'époque.' It would be impossible from Rapp's paper to glean anything with respect to the systematic position of the worm. The first paper dealing with the structure of this worm was published in 1886 by myself (**7**); not long after appeared a paper by Benham (**2**) supplementing my own in several points; both these papers are illustrated by numerous figures; my own paper contains a coloured plate of the worm sketched from life. Shortly after this I examined another specimen of the worm and corrected (**41**) a few inaccuracies in the first paper, identifying as the egg-sac a structure which both Benham and I myself had described as the ovary. Subsequently Benham (**8**) rectified an error in the enumeration of the segments, definitely fixing the position of the ovary in the thirteenth segment, a position which is so very constant among earthworms.

M. rappi is the name which should be used for this species, in my opinion, in spite of Vaillant's criticism; Vaillant considered that the correct name would be '*Microchaeta microchaeta*,' in view of the fact that Rapp's name for the species was *Lumbricus microchaetus*[1]; Rapp, however, at the conclusion of his paper suggested that the worm should form a genus apart from *Lumbricus* with the name *Microchaeta;* and Perrier (**5**, p. 339 footnote) made an identical suggestion; it is not in accord with modern practice to use the same name for the genus and the species; and as the name *M. rappi* is more familiar to zoologists than the one suggested by Vaillant, I shall retain it here.

M. rappi is one of the largest, if not the largest, of earthworms; the living worm examined by myself measured about five feet; this specimen when contracted by spirit was reduced to thirty-eight inches; the length given in the above diagnosis of the species is taken from Benham's paper, which appears to represent about the mean. It is common after rain in various parts of the Cape Colony, and has been noted by several observers to appear only when the ground is thoroughly soaked by the wet; the great bulk of the creature is probably the reason why it can only move about comfortably under such circumstances.

[1] But he put it in genus *Antaeus*.

The colour of the living worm is a bright green dorsally, changing into a pinkish yellow ventrally. The prostomium is not large and is not imbedded in the first segment; the segments are much annulated; the following are the numbers of the annuli given by BENHAM, and illustrated in a figure (fig. 1).

Somites	i and ii	contain	together	3	annuli.
„	iii	„	„	7	„
„	iv	„	„	6	„
„	v	„	„	7	„
„	vi	„	„	6	„
„	vii	„	„	6	„
„	viii	„	„	6	„
„	ix	„	„	4	„
„	x	„	„	3	„

And there are three annuli in succeeding segments.

The extent of the clitellum is a little doubtful. I gave segments x–xxx; BENHAM, segments xiii–xxv; but both these should be placed one segment further back, as apparently both BENHAM and I at first missed the first segment of the body, which is fused with the second. On the anterior segments the setae are longer and thinner than elsewhere and have a spear-shaped extremity; the first segment of the body, which is fused with the second, has no setae at all. The sperm-ducts open externally on to segment xx.

There are five specially-thickened septa; the first of these lies between segments iv/v. The gizzard is in segment vii. In the tenth segment is a pair of calciferous glands which looks like a swelling upon the oesophagus; it is very vascular. The existence of carbonate of lime in the gland has been proved by BENHAM. The intestine commences at about the fourteenth segment and has a typhlosole. The dorsal vessel is double in the anterior region of the body; this duplication begins in the fifth and ends in the ninth segment. The two halves of which the dorsal vessel is in these segments composed does not remain entirely separate; at the septa they unite together to separate again later. In the ninth segment the two halves of the dorsal vessel are extremely wide as compared with what they are in other segments; this state of affairs is very suggestive, as I have already noted, of the commencement of the formation of a heart. In segments v–xi are commissural vessels putting the dorsal and the ventral longitudinal vessels into communication; those of the last four of these segments are larger than the rest and have a moniliform appearance, indicated by BENHAM. The nephridia commence in the third segment; the first twenty pairs (about) have a large caecum attached to the muscular duct

of the organ; afterwards this caecum becomes very much less pronounced. The testes are two pairs in x, xi; each is concealed within a backward prolongation of the median sperm-reservoir (see Pl. iii); with the sperm-reservoir of each segment is connected a pair of sperm-sacs which depend respectively into the eleventh and twelfth segments. The ovary, as I have pointed out, is a body, not identified by BENHAM, in the thirteenth segment; the structures which both BENHAM and I mistook for ovaries are really egg-sacs which occupy the usual segment, i.e. the fourteenth. The spermathecae are in segments xiii–xvi, inclusive; there are not more than eight in any one segment and usually fewer.

(2) Microchaeta beddardi, BENHAM.

M. Beddardi, BENHAM, Q. J. M. S., vol. xxvii, 1887, p. 78.

Definition. *Length, 370 mm. (about); number of segments, 365. Clitellum, XI–XXIII. Calciferous gland in IX, X. Testes, one pair. Spermathecae*[1], *one pair in each of segments XII and XIII. Hab.—Natal.*

This species of *Microchaeta* agrees with the last in most characters; it has the same commencing 'cephalization'—i.e. the second segment as well as the first has no setae, and the two segments are fused. Segments iv–vii are bi-annulate, but the rest are simple. In the alimentary canal the shape of the calciferous gland distinguishes the two species; in the present the gland appears to be single as in the last, but it is nipped at its centre by the septum dividing segments ix/x, and therefore lies partially in both of these segments. The doubling of the dorsal vessel is limited to segments vii–ix.

(3) Microchaeta papillata, BENHAM.

M. papillata, BENHAM, P. Z. S., 1892, p. 141.

Definition. *Length, 250 mm. Calciferous gland in X. Testes, two pairs. Spermathecae, five or six pairs in each of segments XIII, XIV. Copulatory setae, and glands in X and XXVII. Hab.—Natal.*

This species comes nearer to *M. rappi* than to *M. beddardi*; it agrees with the former in the doubling of the dorsal vessel and in the number of hearts, as well as

[1] The spermathecae are stated by BENHAM in his original description of this species to be four in number, a pair to each of segments xii, xiii; in one case there was a variation, an additional spermatheca being present on one side of the body in one segment; this arrangement is figured.

in the points mentioned in the above diagnosis. The setae are, however, ornamented with transverse ridges at the free extremity, as in the majority of Geoscolicidae; it is quite possible that a renewed examination of the two last species will show that the same character exists, for it is one which it is most easy to overlook; the first two segments of the body are more distinct than they are in either of the two last species; but the second segment of the body has no setae; in this particular therefore the present species is intermediate between *M. rappi* and *M. belli.* The gizzard appears to occupy the sixth segment instead of the seventh.

(4) Microchaeta belli, Benham.

M. belli, Benham, P. Z. S., 1892, p. 147.

Definition. *Length,* 200 *mm. Clitellum, XIII–XXI. Calciferous glands, one pair, occupying segments IX, X. Testes, one pair. Spermathecae, two pairs in each of segments XII, XIII. Copulatory papillae on XIII. Hab.—East London, Cape Colony.*

This species comes nearer to *M. beddardi* than does the last; it has, however, ornamented setae like the last species. The anterior segments are bi- or tri-annulate. The apertures of the sperm-duct may be as far forward as the sixteenth segment; Benham traced them as far back as to that segment where they appeared to enter the thickness of the body-wall; it is, however, quite possible that they are continued further within the body-wall before opening on to the exterior. The dorsal vessel is, as in *M. beddardi,* doubled in three segments only.

(5) Microchaeta benhami, Rosa.

M. Benhami, Rosa, Ann. K. Hofm. Wien, Bd. vi, 1891, p. 382.

Definition. *Length,* 300 *mm.; number of segments,* 350. *Clitellum, XIV–XXVII. Calciferous gland in X. Testes, two pairs. Spermathecae, six pairs in XI–XVI. Copulatory glands in XI–XXVIII. Hab.?*

This species of *Microchaeta* differs in several particulars from any other. In the first place it is stated by Rosa to possess no prostomium; this character, it is true, is not by any means unknown in the family Geoscolicidae, but it has not been met with in any other of the Old-World genera. The setae do not commence before the sixth segment. The male pores lie intersegmentally between xx/xxi. As to internal characters, there are only three specially thickened septa—those limiting segments

iv/vii. The gizzard is in vii; the intestine, which has a typhlosole, begins in xiv. The dorsal vessel, contrary to what is found in all other species, is simple throughout; but the hearts are in the same segments as in other species. The two sperm-ducts of each side of the body retain their distinctness until just before the external opening; in other species they join directly after their origin from the funnels. The funnels are said by Rosa to be simple in structure and to pass into the walls of the sperm-sac. The first pair of nephridia possibly opens into the mouth-cavity; the anterior nephridia have no caecum, which is present in those which follow; the exact number however which have no caecum is not stated. The copulatory glands appear to be without setae; they are very much more numerous than in other species.

Genus CALLIDRILUS, Michaelsen.

Definition. Setae paired, the individual setae further apart anteriorly than posteriorly. Spermathecae six pairs in XIII. Male pores open on to XVII through a muscular sac.

This genus is at present only known by a single species, unless we are to regard it as synonymous with the subsequently described *Bilimba* (q. v.). Our knowledge of it is entirely due to Michaelsen (**12**).

This genus agrees with *Kynotus* in having a terminal sac into which the sperm-ducts open; this has been described by Michaelsen in a later paper (**10**); the description is illustrated by a figure. This sac is not muscular like that of *Kynotus*, but consists of an irregular lobate mass of cells with very indefinite boundaries; the nuclei, however, were apparent; a fine canal arises from this body, concerning the destination of which no information is forthcoming; it is suggested that it may be the sperm-duct.

Callidrilus has not got the accessory copulatory structures found in *Kynotus;* in their place are a number of superficial papillae similar to those found in *Acanthodrilus* and other genera (see p. 145). It has, however, as have *Kynotus* and *Microchaeta*, numerous spermathecae in the neighbourhood of the ovaries, occupying only one segment, the thirteenth; some of the pouches lie on one, some on the other side of the septum dividing segments xiii/xiv. The testes and ovaries are quite normal in position; so are the oviducts. Other peculiarities I shall reserve for the description of the species *Callidrilus scrobifer*.

Callidrilus scrobifer, MICHAELSEN.

C. scrobifer, MICHAELSEN, JB. Hamb. wiss. Anst., vii, 1890, p. 20.

Definition. *Length, 76 mm.; number of segments, 248; hinder region of body quadrangular. Clitellum, XV–XXIV; papillae, ten pairs on XI–XVI and XXI–XXIV. Gizzard in V, VI. Septa VI/VII–XI/XII thickened. Hab.—Quilimane.*

The measurements given above may possibly be a little inaccurate; for MICHAELSEN had only incomplete specimens to study. The anterior segments bi- to quadri-annulate; the quadrangular outline of the posterior part of the body recalls the shape of the body in the allied *Siphonogaster*. The skin is entirely free from pigment. The clitellum was not recognizable in the preserved worm; the above statement is given on the authority of STUHLMANN who collected the material for MICHAELSEN. The gizzard is stated to be not very clear; such as it is, it occupies segments v and vi; the intestine commences in segment xii (about). The last pair of hearts is in the twelfth segment. On segments xvii–xxi is a median ventral raised area, which bears anteriorly the male pores. There are four pairs of grape-like sperm-sacs in segments ix–xii.

Genus KYNOTUS, MICHAELSEN.

Syn. **Geophagus,** KELLER.

DEFINITION. **Setae strictly paired, absent upon the first few segments. Spermathecae, usually many in a segment, occupying segments in neighbourhood of female gonads. Sperm-ducts open on to exterior by a muscular sac; in adjoining segments are sacs of copulatory setae, with glands appended.**

This genus was originally described by MICHAELSEN (**10**) from a single, not fully mature example. A second paper, dealing with a second species, permitted a few details to be filled in. More recently ROSA (**13**) has described a third species, which description has added materially to our knowledge of the genus. Some criticisms by BENHAM (**8**), which will be referred to later, complete what has been written upon *Kynotus*.

This genus contains four species, all of them natives of Madagascar[1]. The setae

[1] It has already been pointed out that in all probability *Acanthodrilus verticillatus* of PERRIER is a Geoscolicid referable to this genus.

are strictly paired; they are absent upon the first few segments of the body, as is the case with some other Geoscolicidae; the segment upon which the setae commence varies with the species. The clitellum has only been found in *Kynotus michaelsenii;* in that species it occupies segments xix–xxv; as in *Kynotus michaelsenii* the male pores are upon the fifteenth segment, we have a case of an Anteclitellian worm which is not a Lumbricid. In the other two species the male pores have a more normal position; they open upon segment xvi[1].

In the account given by MICHAELSEN, the position of the organs is very different from that accepted here; this is due to the fact that the author mentioned considered as segments what are really no more than annuli. I follow, therefore, the enumeration given by BENHAM (8) with which that of ROSA appears to agree.

There is a gizzard in segments v or vi; there are no calciferous glands. The nephridia are, as in all other genera of Geoscolicidae, paired structures; the first pair is larger than those which follow, and, according to MICHAELSEN, opens into the pharynx in *K. madagascariensis*. ROSA, however, found that this was not the case with *K. michaelsenii;* the first pair of nephridia in that species open on to the exterior of the body on the second segment; neither these nor the subsequent pairs have any caecum. The reproductive organs are like those of other genera of the subfamily Geoscolicinae; the testes (in *K. michaelsenii*—the only species in which they have been found) are in segments x, xi; opposite to them, in this species, are the funnels of the sperm-ducts in all probability; for ROSA found two separate sperm-ducts on each side of the body. The sperm-ducts open into a terminal muscular sac, which has been described by both MICHAELSEN and ROSA; MICHAELSEN, however, was unable to find the actual orifice of the sperm-ducts into this sac. This sac consists of a terminal muscular portion with exceedingly thick walls, enclosing a narrow lumen with epithelial lining; into the lower part of this, near to the external orifice, opens a tubular gland, which MICHAELSEN compares to the 'prostate' of the other families of Oligochaeta. A more detailed account is to be found in ROSA's paper, which is, however, unfortunately not illustrated by any figures.

In segments xiii and xiv (or xiv, xv) are three or four pairs of small tubular glands in common with each of which opens on to the exterior a sac of modified setae. These structures recall analogous structures in certain species of Acanthodrilidae (see p. 131) more than do the corresponding organs in other Geoscolicinae. The minute anatomy of the glands is, according to ROSA, precisely that of the glandular appendix of the Bursa propulsatoria. The ovaries (only known in

[1] According to BENHAM's interpretation of this segmentation.

K. michaelsenii) are in segment xiii; as to egg-sacs nothing is known. The spermathecae show the same differences in different species that they do in *Microchaeta;* in *K. madagascariensis* and *K. longus* there are a vast number of small pouches in segments xiii, xiv, xv, or xv, xvi; in *K. michaelsenii*, Rosa found only two pairs in xiv and xv.

	SETAE BEGINS.	♂ PORE.	SPERMATHECAE.	COPULATORY GLANDS.
K. michaelsenii . . .	iii	xv	paired in xiv–xv	xiii, xiv
K. madagascariensis .	xvi	xvi	eleven to thirteen pairs in xiv–xvi	three pairs in xiv, xv
K. longus	”	”	three pairs in xv–xvi	” ”
K. kelleri	xviii	xvii	three pairs in xv, xvi, xvii	three pairs in xiv–xvi

Rosa believes that this genus is synonymous with *Geophagus;* but as the latter name is already pre-occupied for a genus of fishes, the name *Kynotus* must stand; the type-species of the genus is—

(1) Kynotus madagascariensis, Michaelsen.

K. madagascariensis, Michaelsen, Arch. f. Nat., 1891, p. 207.

Definition. *Length about 230 mm.; number of segments about 250. Setae lateral. Male pores on XVI. Spermathecae in XIV–XVI, eleven to thirteen pairs in each. Hab.—N. W. Madagascar.*

(2) Kynotus longus, Michaelsen.

K. longus, Michaelsen, JB. Hamb. wiss. Anst., Bd. ix, 1891, p. 63.

Definition. *Length, 800 mm.; number of segments, 770. Setae lateral in position. Male pores on XVI. Spermathecae in XV, XVI, eight pairs in each. Hab.—Sen Bendrana, Madagascar.*

This species is evidently nearly allied to the last; but the above definition shows divergences; in addition to the points of difference there enumerated, it is possible that there are differences in the setae. In both species the setae do not commence before the sixteenth segment; but in the present species the setae are stated by

MICHAELSEN to be ornamented after the fashion so characteristic of the family Geoscolicidae; the copulatory setae also are ornamented by ridges, which is not the case with the same setae in *K. madagascariensis.* It is no doubt possible that, as he himself suggests, the ornamentation may have been overlooked, and may really also exist in *K. madagascariensis;* but in any case the marked ridges upon the copulatory setae of *K. longus* are wanting in the other species. The ordinary setae of both the species are very markedly lateral in position, a condition at least rare among earthworms.

(3) Kynotus kelleri, MICHAELSEN.

K. kelleri, MICHAELSEN, Arch. f. Nat., 1892, p. 254.

Definition. *Length,* 850 *mm. Setae commence on XVIII. Male pores on XVII. Three pairs of copulatory setae and glands on XIV, XV, XVI. Spermathecae three pairs in XV–XVII. Hab.—Madagascar.*

This species is nearest to *K. longus;* unfortunately the inferior state of preservation of the specimens examined by MICHAELSEN did not permit of an at all exhaustive account. The setae are ornamented. The shape of the muscular bulb at the male pore is more oval in form than that of *K. longus.* The copulatory setae bear the same form as in that species. The spermathecae are larger, but less numerous.

(4) Kynotus michaelsenii, ROSA.

K. Michaelsenii, ROSA, Boll. Mus. Zool. Torino, vol. vii, no. 119.

Definition. *Length,* 130 *mm.; number of segments,* 200. *Setae commence upon third segment. Clitellum, XIX–XXV. Male pores on XV; two pairs of copulatory setae on XIII and XIV. Spermathecae two pairs in XIV, XV. Hab.—Madagascar.*

This species is a much smaller one than either of the other two; the single specimen examined by ROSA was compared by him to a *Lumbricus rubellus* in general appearance. The setae appear to be, as in the other species of the genus, lateral in position; they commence much earlier than in the others. The last pair of hearts is in the eleventh segment; nothing is said about the organs of circulation in the former species. In *K. michaelsenii* there do not appear (?) to be any sperm-sacs; but segments ten and eleven are full of masses of spermatozoa.

Genus GLYPHIDRILUS, HORST.

DEFINITION. Setae paired. Clitellum, XXII–XXXII. Nephridia defective in the first fourteen segments. Spermathecae numerous in segments XIV–XIX. Male pores on XXVII, XXVIII. Sperm-ducts imbedded in longitudinal muscular layer, opening with a small spermiducal gland on each side.

This genus is in several respects remarkable. It is at present known only by a single species, *G. weberi*. The extremely posterior position of the male pores distinguish it, though in *Kynotus madagascariensis* they come very near to this species in position, opening, as they do, upon the twenty-fifth segment. The genus, however, differs from *Kynotus* in having setae on the anterior segments of the body. The fact that the nephridia do not begin until the fifteenth segment is a point of resemblance to some of the lower forms of Oligochaeta irrespective of family. It is noteworthy that the present genus is, at any rate, occasionally aquatic in habit. No mention is made of any modified setae. A unique feature in the genus, which may be varietal (though HORST says nothing about the number of specimens in which he found it), is the apparent existence of an additional pair of testes and sperm-duct funnels in the ninth segment; the funnels were not seen to have any connexion with the sperm-duct; but 'a folded membrane lined with a layer of ciliated cells' opposite to a compact body which resembles a gonad can hardly be other than a rudimentary funnel. The spermiducal gland is small, and receives the sperm-ducts of its side just before it opens on to the exterior; nothing could be made out as to its minute structure. The clitellum is bounded below by a long ridge, which is no doubt equivalent to the tubercula pubertatis of other worms. The other characters of the worm will be given under the description of the single species.

Glyphidrilus weberi, HORST.

G. Weberi, R. HORST, Zool. Anz., Bd. xiv, 1891, p. 11.

Definition. *Length*, 120 *mm.*; *number of segments*, 250. *Setae further apart anteriorly than posteriorly. Gizzard in VIII; no calciferous glands; intestine begins in XV. Last heart in XII. Hab.—Java; Sumatra; Flores; Celebes; terrestrial and aquatic.*

Of the external characters—not mentioned in the diagnosis of the species or genus—the dorsal anus is the most remarkable. This recalls the genus *Criodrilus*; it is figured by HORST (**17**) as a triangular and large opening, the wider part being posterior.

The prostomium is incomplete, extending over one-third of the buccal segment. The setae are dorsal and ventral; in the clitellar region they are longer and straighter, but the modification appears to be not striking. The clitellum is variable in extent, from 'six or seven to fourteen' segments; although on an inspection of the worm this region of the body-wall does not seem to commence before the eighteenth segment, in sections glandular cells are observable as far forward as the thirteenth segment. This fact brings the relations of the worm to other Geoscolicidae much nearer than might at first appear. In the neighbourhood of the clitellum are papillae having much the same structure as those of *Acanthodrilus georgianus* (see p. 145); these, too, vary in number and arrangement. They are however, as a rule, paired. In the alimentary canal the describer of the species mentions the typhlosole as existing only in segments xix, xx; in addition to this 'singular longitudinal folds are to be seen here at the ventral side of the intestine.' The sperm-sacs are present to the number of four pairs in ix–xii. The number of pairs of spermathecae in each of the segments where they occur varies from one to three; in some cases, as in *Allolobophora complanata*, the spermathecae lay in two segments. The spermathecae were occasionally absent even in otherwise fully mature worms. In his more detailed account of this species (**17**) Horst has illustrated its anatomy.

Genus ANNADRILUS, Horst.

Definition. Setae strictly paired, not ornamented. Male pores on XXI/XXII. Nephridia missing in first twelve segments. Spermathecae in XIV, XV, XVI, more than one pair in each segment.

This genus comes near to *Glyphidrilus*, but may be distinguished by a few characters; a further acquaintance with the two genera may lead to the fusion of the two. In the meantime I follow Horst in allowing them to be distinct. The main difference is in the absence in the present genus of spermiducal glands; the different position of the male pore I regard as of less importance.

Annadrilus quadrangulus, Horst.

A. quadrangulus, Horst, Zool. Ergebn. Ost-Ind., ii, p. 44.

Definition. *Length,* 50 *mm.; number of segments, about* 200. *Body rather quadrangular posteriorly, with the setae implanted at the corners. Clitellum, XIX, XX–XXV. Gizzard in VIII. Sperm-sacs in IX–XII. Spermathecae, four pairs in XIV, five pairs in XV, and two pairs in XVI. Hab.—Sumatra, in Lake Danau di atas.*

The clitellum in this worm has the same ridge that is seen in *Bilimba papillata;* it extends over all the clitellar segments. There are no other copulatory structures. HORST found that the alimentary canal contained a large quantity of Diatomaceae; hence it was inferred that the worm lived in the soil at the bottom of the lake in which it was found. The species is not very fully described, and is not illustrated by HORST in his paper.

Genus HORMOGASTER, ROSA.

DEFINITION. **Setae of dorsal series strictly paired, those of ventral series far apart; clitellar setae much larger than others, ornamented. Clitellum, XV–XXV. No calciferous glands; three gizzards in VI, VII, VIII. Spermathecae in X, XI, XII; sperm-sacs, two pairs in XI, XII; one pair of egg-sacs in XIV.**

This genus was apparently first described by REDI in the year 1684; two centuries later it was re-described by ROSA (**7**). It has not been investigated by any other naturalist. The genus only contains one species, hitherto only known from Italy. The principal features in its structure are the following:—

The setae have the usual form of these organs; but they are implanted in a rather unusual fashion, except among the Eudrilidae; the two setae of the ventral couple are somewhat widely separated; on the other hand, the two setae of each dorsal couple are very close together. Upon the clitellum, as is usual in the Geoscolicidae, the setae are different in character from those found elsewhere; they are here much longer and straighter and the free extremity is ornamented, though apparently not in so marked a way as in such a genus as *Pontoscolex.* The clitellum is but little prominent; nor is it very distinct from the surrounding segments by a difference of colour; it extends from the fifteenth to the twenty-fifth segment. The most abnormal external character of the genus is the position of the male pores upon the border line between segments xv/xvi; this place of opening is found in but few other Geoscolicids and is so far an indication of affinity with the Lumbricidae. BENHAM, indeed, is inclined to refer it to the family Lumbricidae. In the digestive organs, the most noteworthy points are the presence of three gizzards and the absence of calciferous glands; there is no other member of the family in which I place the genus in which there are three gizzards; and as a rule (to which, however, there are exceptions, such as *Siphonogaster*) calciferous glands are to be found; the three gizzards of *Hormogaster* lie in segments vi, vii, and viii respectively;

the oesophagus extends to the twentieth segment; in the twenty-first begins the intestine, which has a typhlosole; this typhlosole gets to be, in segment xxviii, of enormous size, almost filling up the lumen of the intestine; it is figured by ROSA as being much folded. The first part of the intestine occupying segments xxi–xxviii has faintly marked lateral caeca; after the last-named segment, these caeca disappear and the intestine presents a normal appearance. It is in the posterior section of the intestine that the typhlosole acquires its full development. Concerning the circulatory system, ROSA gives but few details; a subnervian vessel exists; in the anterior region of the body the dorsal vessel is double, a condition common among earthworms. There appears to be no supra-intestinal vessel; at least, no mention of one is made.

The reproductive organs present no special features of interest; the usual two pairs of testes lie attached to the anterior septum of their segments in segments x and xi; opposite to them are the funnels of the sperm-ducts; the two ducts of each side unite in the twenty-first segment and pass on to the external pore, which is, as already stated, upon segment xv/xvi. The sperm-sacs are racemose organs and lie in segments xi and xii, being confined to these segments and not extending beyond them as is so often the case with worms belonging to this family; as in *Microchaeta*, and in certain other genera of Geoscolicidae, there are egg-sacs—one pair in segment xiv. The ovaries and the oviducts are perfectly normal.

Hormogaster redii, ROSA.

H. redii, ROSA, Mem. R. Acc. Torino (2), xxxix, 1889, p. 49.

Definition. *Length,* 160 *mm.; number of segments,* 300–380. *Colour earthy brown, fleshy below. Nephridiopores in front of second seta, commencing with the fifth segment. Hab.—Italy.*

Genus SIPHONOGASTER, LEVINSEN.

DEFINITION. **Setae paired, ornamented. Clitellum?; on eighteenth segment a pair of long penial processes, provided with modified setae, in the middle of which open the sperm-ducts. Oesophagus without gizzard or calciferous glands. Spermathecae absent.**

This genus was first made known by LEVINSEN, who described (**1**) a single species from the banks of the Nile from material in a poor state of preservation. Two species from the shores of Victoria Nyanza were subsequently investigated by

MICHAELSEN (**11**)[1]; and, more recently still, I have been able to add to our knowledge of the genus by the study of well-preserved examples of a fourth species from Lagos, West Africa (**39**).

Neither LEVINSEN nor MICHAELSEN were able to fix the systematic position of this Annelid. My own observations have shown conclusively that it is a member of the family Geoscolicidae.

The most salient character of the genus is the possession of long penial processes arising from the body at about the eighteenth segment. The function of these processes is, of course, only a matter of conjecture at present; it appears likely that they serve to hold the worms together during sexual congress. These 'penes' are furnished with suckers on one surface and with modified setae arising from the bottom of these pit-like suckers. These organs are richly supplied with blood-vessels, and this fact led LEVINSEN to regard them as being respiratory organs as well as penes; as the structure of these processes is excessively glandular this is sufficient to account for a rich vascular supply without going so far as to assign an additional function to them. Underneath the epidermis with which the penis is covered by an irregular layer of pyriform glandular cells with long processes which are the ducts of these uni-cellular glands; the ducts open between the epidermic cells; the rest of the penis is occupied by muscular fibres and the blood-vessels. There are, however, a few tubes which have the strongest possible resemblance to nephridia; they are not connected with the nephridia of the segment of which the penes are outgrowths. The vas deferens runs in this penis; it opens on to the exterior at about the middle of the organ. As in *Acanthodrilus annectens* these tubes do not lie freely within the body cavity, but run deep within the musculature of the body; immediately after they arise from the funnel they plunge into the thickness of the body-wall. This is one of the more remarkable features in the structure of the reproductive organs; another peculiarity is the total absence of spermathecae. MICHAELSEN, who was the first to point out the fact, suggests that it may have something to do with the aquatic habit of the worms. He instances *Criodrilus* as being also devoid of these pouches; but there are, of course, many other aquatic Oligochaeta which have spermathecae as well as some purely terrestrial forms which have them not.

I have not been able to detect a clitellum in the species investigated by myself; neither is there any mention of it in any other paper dealing with the genus. The example of *Moniligaster* teaches us to be careful in asserting the absence of this characteristic Oligochaetous organ; otherwise it might be suggested that the presence of the long penes would render the function of a clitellum rather difficult, and that

[1] I have not incorporated MICHAELSEN's latest paper (16).

possibly the glandular cells of the processes may also serve to form the cocoon, should such exist—which is not yet known. In any case it is remarkable that in fully adult specimens there should not be the least trace of a clitellum. The genus is further characterized by the entire absence of gizzard and calciferous glands.

Four species of *Siphonogaster* have been described; these are:—

(1) **S. aegyptiacus,** LEVINSEN, Nile.
(2) **S. millsoni,** BEDDARD, Lagos.
(3) **S. emini,** MICHAELSEN, Victoria Nyanza.
(4) **S. stuhlmanni,** MICHAELSEN, Victoria Nyanza.

The distribution area of these might lead to the inference that they were separate, particularly in the case of *S. millsoni*, for there is not, at present, a single instance of the same species occurring on both sides of the African continent.

The two last-mentioned species are principally to be distinguished by the form of the genital seta, which in *S. stuhlmanni* have not the spatula-like outline that they have in *S. emini* and the other two species; there were also only a single pair of them. The distinctness of *S. emini* and *S. aegyptiacus* is not so certain. MICHAELSEN defines it chiefly by the absence of the penes and their replacement by 'dicke, hohe, wulstförmige Hervorragungen.' It is suggested too that a median ventral line between these processes bears the spermiducal pore. If the last suggestion proves true the distinctness of the species (from *S. millsoni*, at any rate) is clear. But it has certainly to be proved. I am not disposed to allow that there is necessarily any difference in the penial processes; in immature individuals of *S. aegyptiacus* from the Nile mud I have found the processes in question very much in the same condition as they are figured by MICHAELSEN; so too in the case of immature specimens of *S. millsoni*. With regard to these two species it is very difficult in the present state of our knowledge of *S. aegyptiacus* to separate them. The only difference seems to be that in *S. aegyptiacus* the penial setae are irregularly arranged upon the penes, whereas in *S. millsoni* they form two approximately regular series.

(1) Siphonogaster aegyptiacus, LEVINSEN.

S. aegyptiacus, LEVINSEN, Vid. Med., 1889, p. 319.
? **S. Emini,** MICHAELSEN, JB. Hamb. wiss. Anst. ix, 2, 1892, p. 8.

Definition. *Length, about* 130 *mm.; diameter,* 3–4 *mm.; number of segments,* 150. *Setae not ornamented* (?). *Penial setae arranged irregularly on the penial processes. Hab.—Nile; Bukoba, Victoria Nyanza.*

The setae, except for the apparent absence of ornamentation, which, I imagine, requires confirmation, are, judging from the figures in the papers above quoted, exactly like those of *S. millsoni.*

(2) Siphonogaster millsoni, BEDDARD.

S. millsoni, BEDDARD, P. Z. S., 1891, p. 48.

Definition. *Dimensions about the same as in the last species. Body markedly quadrangular posteriorly. Setae ornamented. Penial setae arranged more or less regularly in two rows. Hab.—Lagos.*

The above points are all the differences which the published descriptions of the species allow me to extract. *S. millsoni* has been described more fully than the others, and by myself (**39**). The setae are most distinctly ornamented, the ordinary setae as well as the penial. For the habits of this, the 'Yoruba-worm,' see MILLSON.

The quadrangular form of the body appears to be very characteristic of the species. In transverse sections (of which no description was given in my paper upon the worm) the body-wall is seen to be greatly thickened at the four corners; the thickening is entirely at the expense of the longitudinal muscular layers; the dorsal, ventral, and lateral surfaces are comparatively thin, particularly the dorsal. The outline of such sections forms an oblong, the lateral diameter being greater than the dorso-ventral.

The nephridia are paired structures, and their external pores are related to the ventral setae. There is not a terminal muscular sac present. They do not begin before the fifteenth segment. The vascular system is remarkable for the fact that there are two subnervian vessels running in close contact with the body-wall, along the two sides of the nerve-cord; they are each about one-half of the size of the ventral blood-vessel. There seems to be no supra-oesophageal blood-vessel; in segments viii–xii are hearts connecting the dorsal and ventral blood-vessels.

The oesophagus (without a gizzard) extends back to segment xvii; after segment ix its walls are very vascular; the intestine is sharply marked off from the oesophagus by its much taller epithelium, and by the much feebler vascular supply. The intestine is for the space of one segment no wider than the oesophagus which precedes it; this region too has a taller epithelium; in the eighteenth segment it suddenly widens out, but does not begin to show the regular and characteristic constriction for three segments after this. The muscular coat of these two parts of the intestine is very much thickened, and, although the lining epithelium, as already mentioned, is ciliated

and has no cuticle, we may look upon this region of the gut as comparable to the posteriorly situated gizzards of *Bilimba*, &c. The intestine has no typhlosole.

None of the intersegmental septa are greatly thickened; the first seven or eight are rather stouter than those found elsewhere.

The sperm-sacs extend from segments ix to xiii. The oviducts do not, as I erroneously stated in my paper upon this worm, lie in a single segment; but their pores are strictly intersegmental (xiii/xiv) in position.

(3) Siphonogaster stuhlmanni, MICHAELSEN.

S. Stuhlmanni, MICHAELSEN, JB. Hamb. wiss. Anst., ix, 2, 1892, p. 10.

Definition. *Length (apparently) less than in other species. Penial setae not spatulate in form, but like the ordinary setae of the body, though much smaller. Two pairs only, one to each penial process. Setae not ornamented. Hab.—Victoria Nyanza.*

This species is only known from two fragments, and its dimensions, therefore, cannot be stated. The extraordinary difference in size between the penial and the ordinary setae is illustrated by MICHAELSEN; the actual measurements are:—penial seta, ·172; ordinary seta, ·5. The limited number of the genital setae (one pair to each penis) and their shape (much like the ordinary) serves to distinguish the species. A few notes are given by MICHAELSEN upon the internal anatomy, which does not appear to differ from that of *S. millsoni*.

Genus BILIMBA, ROSA.

DEFINITION. Setae paired, further apart anteriorly, not ornamented. Gizzards numerous. Spermathecae wanting (?).

As there is only a single individual belonging to this genus in existence, it is impossible to differentiate generic from specific characters; and as that specimen was immature it is impossible to give a full definition. The spermathecae may not, of course, be really absent. As, however, the sperm-sacs (in ix–xii), the funnels, the ovaries, the egg-sacs, and the oviducts were all formed, the absence of spermathecae may be a generic (or specific) character. On segments xviii–xxiv is a raised band on either side, as in *Annadrilus*—a structure which naturally recalls the tubercula pubertatis of many Lumbricids. A marked feature of *Bilimba papillata* is one

which has given its name to the species—the presence of numerous papillae. There is nothing said about their minute structure; the number and arrangement seems to me to be in all probability a specific character. The numerous gizzards, the last of which is situated in the eighth segment, are a peculiarity of the genus, unique in the family.

Bilimba papillata, Rosa.

B. papillata, Rosa, Ann. Mus. Civ. Genova, vol. x (2a), 1890, p. 386.

Definition. *Length*, 100 *mm.; diameter*, 5 *mm.; number of segments about* 330. *Prostomium not at all imbedded in buccal segment. Papillae: eight median, unpaired on XI–XIV, XVII, XXVI–XXVIII; seven pairs on XIII–XVII, XXIV, XXV. Hab.—Cobapo, Burmah* (1000–14,000 *feet above sea-level*).

The body of this species, as in several other Geoscolicids (e.g. *Criodrilus*), is quadrangular in section posteriorly.

Family LUMBRICIDAE.

Definition. **Terrestrial (rarely aquatic) Oligochaeta, usually of moderate size; setae eight in number in each segment. Male pores on XII, XIII or (most generally) XV. Clitellum, saddle-shaped, commences some way after the segment bearing the male pores. Dorsal pores present. Gizzard always single, placed at end of oesophagus. Nephridia paired and all similar. No spermiducal glands or penial setae. Tubercula pubertatis nearly always present. No supra-intestinal blood-vessel.**

This family of Oligochaeta is one of the most easily to be characterized. Though it contains a large number of species the range in variation of structure is very small; so much so that the division of the family into genera is a matter of difficulty. I have eliminated from the present family the genus *Criodrilus*, the reasons for which proceeding will be found stated on p. 666.

The Lumbricidae are, nearly all of them, worms of moderate size. *Allolobophora gigas* is the only species which vies with some of the gigantic earthworms of the tropics. On the other hand, there are a few very small species.

The *setae* have the usual ʃ-shape characteristic of the terrestrial Oligochaeta. They are invariably eight in number to each segment of the body, and may be more or less strictly paired. Occasionally (*A. foetida*, &c.) they are, as in Geoscolicidae, ornamented at free extremity.

The Lumbricidae also resemble the Geoscolicidae in that the clitellar setae are commonly modified in shape, though they never exhibit the ornamentation so characteristic of the last-named family. The setae in question are very much longer and thinner than those upon the non-clitellar segments. In *Allurus* (at any rate in one species of that genus) the clitellar setae have a spear-shaped termination.

The *clitellum* in this family is always saddle-shaped, and it always occupies a posterior position, never commencing before the eighteenth segment (*Tetragonurus pupa*); in one instance (*Allolobophora molleri*) it begins so far back as the forty-eighth segment. These are the two extremes, and almost every intermediate position is met with.

Highly characteristic of the Lumbricidae are the structures first called by Eisen the Tubercula pubertatis. These structures in fact, at any rate in the peculiar form which they show in the Lumbricidae, appear to be confined to that family. They are prominent papillae, sometimes paired, and sometimes taking the form of a pair of bands running continuously over several segments. Their structure is like that of the clitellum, and they appear before that organ on some of the segments which will be occupied by it. Their position corresponds to the interval between the dorsal and ventral setae, and, therefore, to that of the male pores with which they are sometimes united by a groove, which has been noticed by several writers (e.g., Cerfontaine). In two Lumbricids only are the tubercula absent; and Rosa (4) has shown that in these two cases (*Allolobophora eiseni* and *A. constricta*) the spermathecae are also absent.

The male pores, excepting in the genera *Tetragonurus* and *Allurus*—where they are upon the twelfth and thirteenth segments respectively—are upon the fifteenth segment. The only other terrestrial Oligochaeta in which the male pores occupy this position is the Geoscolicid *Kynotus michaelsenii*. Very commonly the lips of the apertures are tumid owing to the great development of glandular cells; in the few species in which this is not the case the male pores are very inconspicuous [1].

As regards internal structure the Lumbricidae are chiefly to be distinguished by negative characters. The gizzard is always single and at the end of the oesophagus,

[1] This is duly noted in the descriptions which follow; if nothing is said it is to be assumed that the pores are prominent.

lying therefore behind the calciferous glands. The latter appear to be invariably present, but they have only been investigated in a few forms. I have already referred to the curious fact that out of the three pairs only one communicates with the oesophagus. Rosa (**15**, p. 15) has commented upon the differences in appearance presented by the calciferous glands of different species. The intestine always has a typhlosole. There is no supra-intestinal blood-vessel, and the last pair of hearts are not situated further back than in the eleventh segment.

The reproductive organs only vary in the number and position of the spermathecae and in the position of the male pore, which has been already referred to.

The testes are always two pairs in x, xi, and there are a corresponding number of funnels. The sperm-sacs, as mentioned below, vary in the two genera *Lumbricus* and *Allolobophora*. The ovaries, oviducts, and egg-sacs occupy the usual position and appear to show no variation[1].

The *spermathecae* are spherical or oval sacs, absent only in *Allolobophora eiseni* and *A. constricta*, which vary considerably in number, particularly in the genus *Allolobophora* (q.v.). In no case has the spermatheca a diverticulum; it is true that in *A. complanata* I described some years back (**13**) an appearance of the spermathecae suggestive of a diverticulum; in fact, in several cases the spermatheca was divided into two parts, one lying in front of, and the other behind the septum; but neither part could be called a true diverticulum of the other; there was no difference in minute structure, such as one always finds in a diverticulum, and really no more than a constriction, covered by the septum, divided the two parts of what is really one sac. The most aberrant species in point of its spermathecae is *A. leoni;* there are here a large number of pairs of small spermathecae in a single segment; this is not necessarily, however, a point of similarity to the Geoscolicidae, in many genera of which we meet with the same thing, since more than one species of *Perichaeta* (see p. 428) is characterized by the same structural feature.

Affinities. The Lumbricidae are in some respects a very isolated family, and, as has been already remarked, they show a great uniformity in structure. There are no aberrant forms to give any distinct clue to the affinities of the family. Nevertheless it seems, on the whole, that the most nearly related group is that of the Geoscolicidae. And the principal resemblances between the two families are the following:—

(1) The clitellum in the Lumbricidae is always saddle-shaped: nearly always in the Geoscolicidae.

[1] I do not, of course, refer here to individual, but to specific variations.

(2) The clitellar setae are usually modified in both families, being longer than those upon the non-clitellar segments.
(3) The spermathecae are without diverticula.
(4) There are no spermiducal glands in the Lumbricidae, and these structures are absent in a large number of Geoscolicidae.
(5) The supra-intestinal blood-vessel is wanting in the Lumbricidae, and in many, if not most, Geoscolicidae.

Besides these general facts of resemblance, which point to an affinity between the two groups, there are a few points of similarity shown by individual genera and species. Thus Rosa has pointed out that in *A. complanata*, the commencement of the large intestine is sacculated, as it is in certain Geoscolicidae, for example *Hormogaster*. The last-named genus also approaches the Lumbricidae, in that the male pores are situated between segments xv/xvi. In another Geoscolicid, viz. *Kynotus michaelseni*, the male pores are actually upon the fifteenth segment.

It should be perhaps remarked that the invariably paired character of the nephridia is another bond of union between the Lumbricidae and the Geoscolicidae.

The Lumbricidae are found in nearly every part of the world. But they are most characteristic of the Palaearctic and Nearctic regions of Sclater. In fact, they practically constitute the earthworm fauna of these regions, but few additional types being found. An important question is—How far are they really indigenous to tropical countries? I have entered into this question already (p. 149) more fully, but a few points may be noted here.

The most striking fact in favour of considering the Lumbricidae to be indigenous to Europe, Asia, and North America, and to have been introduced accidentally elsewhere is the *invariable identity* of Lumbricidae met with outside those two regions with forms well known from Europe, North Asia, and North America. If different species were found, for example in New Zealand, the possibility of the Lumbricidae being a genuine case of a widely distributed family would have to be reconsidered.

The genus *Lumbricus* of older authors was divided by Eisen into the two genera *Lumbricus* and *Allolobophora*; they are thus defined by him:—

Lumbricus (s. s).—'Tubercula ventralia in segmento 14. Setae ubique binae approximatae. Lobus cephalicus postice segmentum buccale in duas partes dividens.'

Allolobophora.—'Tubercula ventralia in segmento 14. Setae ubique binae approximatae. Lobus cephalicus postice segmentum buccale non dividens.'

The first two sentences in these definitions serve to separate both genera from *Allurus* and *Dendrobaena;* the latter is thus defined:—

Dendrobaena.—'Tubercula ventralia in segmento 14. Setae ubique aequo intervallo distantes exceptis duabus summis quarum intervallum aliquanto majus est. Lobus cephalicus tres partes segmenti buccalia occupans.'

These definitions obviously rest upon rather slender differences. Those who have followed EISEN have usually accepted his genus *Allolobophora,* but not allowed *Dendrobaena;* in this way the species belonging to the three genera will be separable into two series according as to whether the buccal lobe does or does not completely divide the buccal segment. This is, for instance, the position taken up by ROSA in his earlier paper upon the Lumbricidae of Italy.

OERLEY has, however, proposed a still further division of the Lumbricidae. He resuscitates the old name of *Enterion* for a portion of *Lumbricus;* and divides *Allolobophora* of EISEN into *Allolobophora, Octolasion,* and *Aporrectodea. Octolasion* is used for those species with setae in eight rows; the two other genera have paired setae, but in the genus *Allolobophora* the tubercula pubertatis form a continuous streak; they are separate in *Aporrectodea.*

FRIEND has lately revived the name of *Dendrobaena,* using it as one of three subgenera (the others being *Lumbricoidea* and *Mucida*) of *Allolobophora.*

The last attempt at subdividing *Allolobophora* is by ROSA. He allows four subgenera of *Allolobophora,* viz. *Allolobophora, Notogama, Dendrobaena,* and *Octolasion;* they are characterized as follows:—

(1) **Notogama.**—Four pairs of sperm-sacs, testes and funnels free; spermathecae opening near to dorsal median line.

(2) **Dendrobaena.**—Three pairs of sperm-sacs, testes and funnels free; spermathecae opening in front of dorsal setae.

(3) **Allolobophora.**—Four pairs of sperm-sacs, testes and funnels free; spermathecae as in last.

(4) **Octolasion.**—Four pairs of sperm-sacs, with four seminal sacs enclosing testes and funnels; spermathecae opening in front of setae.

To these he appears to be disposed to add a fifth for those species in which there are only two pairs of sperm-sacs; he admits also that there are a number of other species which cannot be grouped in either subgenus. In the above definitions colour and arrangement of the setae are left out because they are not constant in a given subgenus; for example, in *Notagama* the setae are paired or more distant, and the pigment may be present or absent in the skin of the back.

The very fact that there are species which cannot, in the present state of our knowledge, be included in one or other of these groups, leads me to leave it for the present. As to the two genera *Lumbricus* and *Allolobophora*, ROSA distinguishes them by a better character than that adopted by EISEN and by many who have followed him. In the genus *Lumbricus* the prostomium always completely divides the buccal segment, and in addition there is invariably a single median sperm-reservoir which encloses the testes and funnels; in a few species of *Allolobophora* there is, either occasionally or always, a similar complete division of the buccal segment, but there is never a single median sperm-reservoir though there may be a number of pairs of such reservoirs. This definition is accepted in the present work rather as a convenient way of dividing up the numerous species than in the belief that it is a character of first-rate importance; if other families of earthworms were divided by characters as slender the number of genera would be immense.

Another genus has been separated by EISEN and thus defined: 'Setae ubique binae approximatae: Tub. ventr. in segm. 12 pone segm. buccale.'

This genus *Allurus* has been until quite recently accepted by all writers on the group, except VAILLANT (**6**), who only allows it as a subgenus. Recently MICHAELSEN (**8**, p. 9) has extended EISEN'S definition so as to include a few other forms described by himself and ROSA.

MICHAELSEN was disinclined to allow the position of the male pore (practically the only distinguishing mark mentioned by EISEN) to have generic value, pointing out that among the Enchytraeidae it is impossible to separate for a similar reason *Buchholzia appendiculata* and *Marionia sphagnetorum* from the other members of their respective genera. In these instances, however, it is the entire genital apparatus that has been shifted forwards; not, as in the case of *Allurus*, the male aperture only. The genus *Tetragonurus* of EISEN, in which the male pores are still a segment in front of the normal (for *Allolobophora*), is also included in the genus, which is chiefly characterized by MICHAELSEN as having a more anteriorly situated clitellum (not extending further back than the twenty-seventh segment) and strictly paired setae. If this be allowed it will, it might be urged, become necessary to separate *Allolobophora molleri* as a distinct genus. In this worm the clitellum is as unusually posterior in position as it is anterior in *Allurus;* besides *A. molleri* has the spermathecae in segments viii, ix, a very unusual—indeed unique position —for these organs, when there are only two pairs. In my opinion, therefore, we need a better character than that afforded by the position of the clitellum, which in any case varies greatly in admitted members of the genus *Allolobophora* (sensu MICHAELSENI). The extremes are, apart from *A. molleri*, *A. mucosa* xxv–xxxii, and

A. minima, xxxiii–xxxvii. The separation here is not only quite as far but further than that between *Allurus tetraedrus*, xxii–xxvii, and *Allolobophora japonica*, xxiv–xxxi. As for the *fewness* of the segments included in the clitellum of *Allurus*, *Allolobophora studiosa* has only six segments in its clitellum, a number only greater by one than the number found in *Allurus ninnii*.

In specimens of *Allurus* from Teneriffe and from New Zealand, I have found that the clitellar setae have a peculiar form which is characteristic; the free extremity of the seta has a spear-head termination; I do not know how far this really distinguishes the species *Allurus tetraedrus* of the genus *Allurus* in general from *Allolobophora;* but if it is not to be found in *Allolobophora* or *Lumbricus*, then it appears to me that this character, coupled with the position of the male pores upon the thirteenth segment, is perhaps enough to distinguish the genus. In any case the genus *Allurus* will be retained here as thus defined. In default of any information as to the internal structure of *Tetragonurus*, I shall retain that genus also.

Quite recently MOORE has introduced a new genus under the name of *Bimastos*. The clitellum (xxiii–xxviii), absence of spermathecae, and position of male pore (on xv) show that the genus is a Lumbricid; but the author speaks of a pair of large glands communicating with the male pore. If these are anything more than the swollen integumental crests which surround those pores in most other Lumbricidae, the genus may be distinct.

The number of species belonging to the three genera of the Lumbricidae is very large; but the number of names given is, of course, considerably in excess of this. VAILLANT gives descriptions of no less than fifty-eight species, which he regards as identifiable; thirty-six are enumerated, which are either placed as '*incertae sedis*,' or are termed '*Lumbrici dubii*.' Since VAILLANT'S work has been published about thirty genuine species of these genera have been added to the list by MICHAELSEN and ROSA. The list of VAILLANT can be reduced considerably and without any doubt. He includes a number of species which are most obviously not *Lumbricus* or *Allolobophora;* a few other species, too imperfectly described by their original describers, have been shown to be wrongly placed in any of the genera which compose this family; the list may, finally, be reduced by eliminating a number of species which are certainly members of the family Lumbricidae as here defined, but are for various reasons no longer recognizable. It will be advantageous, I think, to treat of those in the present chapter, and not encumber the description of the species with discussions as to the identity of various forms, concerning which there is really not sufficient evidence. Where there is, in my opinion, clear evidence as to the identity of a species

described by one of the older authorities, I insert those reasons under the description. It will clear the ground if a commencement be made by eliminating a number of species, which are not referable to *Lumbricus* or to its immediate allies; I shall, however, only include in this list earthworms which were really assigned to the genus *Lumbricus*, because the describers of the species lived at an epoch when hardly any other genera had been made known, and those only by external characters. I leave out of consideration such forms as '*Lumbricus*' *tubifex*, of whose identity there is no doubt, and '*Lumbricus*' *glacialis* which is, of course, an Enchytraeid.

(1) *Lumbricus americanus* of Perrier (3, p. 44) is not a recognizable worm. This species appears to be an *Allolobophora*, from the fact that the funnels of the sperm-ducts lie freely in the segment, and are not enclosed within sperm-reservoirs. The only points of specific importance mentioned are—setae strictly paired; spermathecae two pairs in ix, x; clitellum extending over six segments, commencing with the thirty-first. These are not enough to enable the species to be placed.

(2) *Lumbricus victoris*, also of Perrier (3, pp. 48, 103) in having three pairs of spermathecae (in ix, x, xi) resembles *Allolobophora chlorotica;* here, however, the likeness ends; for, in *Lumbricus victoris*, the dorsal pore commences between viii/ix or perhaps vii/viii, and the clitellum occupies segments xxv–xxxii; if one were certain that the number of spermathecae was the normal, the species might be allowed.

Lumbricus dubius, Dugès (3, p. 20), is said to be closely allied to *L. blainvilleus*, and to possess a clitellum, xxvi–xxxii, and tubercula on xxviii and xxx.

Lumbricus stagnalis of Hoffmeister (1, p. 35) is a semiaquatic species found in stagnant water in the Harz. The setae are distant, the prostomium incomplete; the clitellum consists of vii–x segments (xxvi, xxvii, xxix–xxxiv, xxxv, xxxviii), the exact position of the tubercula not being noted. The hinder end of the body is tetragonal. Most writers have sought to identify the species with *A. complanata*, but Rosa holds that it is probably a distinct species, which clearly requires further investigation.

Lumbricus isidorus, Dugès (3, p. 22), is a doubtful species. It is described by Dugès as having been given to him by Geoffroy St. Hilaire, who found it in a saline spring[1]. It has a violet colour, paired setae, and the clitellum extending over segments xxvii–xxxii. It has two longitudinal bands (the tubercula pubertatis?), but their exact position is not stated. The species is evidently an *Allolobophora:* in addition to the above points the prostomium is incomplete, but its exact position is a matter of doubt.

Lumbricus blainvilleus, Dugès (3, p. 20), has paired setae and a clitellum extending over segments xxvi–xxxiii; tubercula pubertatis between xxvii/xxviii and xxix/xxx. It seems to be near *A. norvegica*.

Lumbricus mollis, Dugès (3, p. 18), has a clitellum extending over segments xxvii–xxxvi, paired setae, and an incomplete prostomium. As the position of the tubercula is not mentioned, its identity is a matter of great doubt. Hoffmeister thinks it is identical with *L. teres* of the same writer; Vaillant has pointed out that this can hardly be, since the latter species has

[1] 'Dans les eaux minérales salines et froides.

a complete prostomium (the prostomium of *L. mollis* is figured by DUGÈS (3, Pl. I, fig. 2). ROSA believes *L. teres* to be the same as *A. terrestris*, in spite of the prostomium.

Lumbricus valdiviensis (BLANCHARD), *L. castaneus* (RISSO), *Enterion cinctum* (FITZINGER), *L. giganteus* (RISSO), *L. clitellinus* (RISSO), *L. caeruleus* (RISSO), *E. firmatorum* (FITZINGER), *E. vaporariorum* (FITZINGER), *L. roseus* (RISSO), *L. xanthurus* (TEMPLETON, 2), *L. omilurus* (TEMPLETON, 2), *L. minor* (JOHNSTON, 1), *L. lividus* (JOHNSTON, 1), *L. josephinae* (KINBERG), *L. armatus* (KINBERG), *L. luteus* (BLANCHARD), *L. ephippium* (GRUBE, 7), *L. infelix* (KINBERG [1]), *L. alyattis* [2] (KINBERG), are quite unrecognizable species; they all of them appear to be members of the family Lumbricidae, the inference that this is so being derived from their habitat or from the position of the clitellum when given. It is possible that in a few cases Geoscolicids may have been included in this list; the clitellum, in that family, is sometimes as posterior in position as it is in the Lumbricidae. But, even if this mistake has been made, no great harm will have been done.

Genus ALLURUS, EISEN.

Syn. **Lumbricus,** AUCT. (in part.).
Allolobophora, AUCT. (in part.).
Enterion, SAV. (in part.).

DEFINITION. **Male pores on segment XIII. Clitellum, XXI–XXVII (about). Setae paired. Clitellar setae of peculiar form.**

The anatomy of this genus has been dealt with principally by myself (**46**). But the absence of anatomical data respecting several of the reputed species renders it a matter of great difficulty to decide upon the admissibility of some of these. MICHAELSEN allowed four species, viz.

(1) **Allurus neapolitanus** (OERLEY).
(2) **Allurus tetraedrus** (SAV.).
(3) **Allurus ninnii** (ROSA).
(4) **Allurus hercynius** (MICH.).

In his recent revision of the Lumbricidae (**15**) ROSA retains these species, but is of opinion that they are probably referable to two only, viz. *A. tetraedrus* (incl. *A. hercynius*), and *A. neapolitanus* (incl. *A. ninnii*). The only difference being in each case that the male pores are upon segment xv instead of xiii.

They are thus distinguished:—

(1) **Allurus tetraedrus.** CLIT. XXII–XXVII, TUB. PUB. XXIII–XXVI.
(*a*) ♂ pore on xii, **A. tetraedrus.**
(*b*) ♂ pore on xv, **A. hercynius.**

[1] The male genital pores are said to be on xvi; the worm, therefore, may be a Geoscolicid.
[2] This is identified by ROSA (15, p. 59) with *Allolobophora cyanea*.

(2) **Allurus neapolitanus.** CLIT. XXI–XXV, TUB. PUB. XXI–XXIV.

(*a*) ♂ pore on xiii, **A. neapolitanus.**

(*b*) ♂ pore on xv, **A. ninnii.**

MICHAELSEN argues that, since in *A. hercynius* it is the male pore only which has a different position, the other organs being as in *A. tetraedrus*, and since in a variety of *Allolobophora putris*, the female as well as the male apertures had been shifted, the position of the male pore in *A. hercynius* is a valid specific distinction. If so, then one of the varieties of *Perionyx excavatus*, in which the male pores are normal in position but the female pores abnormal, should be regarded as entitled to specific rank.

FRIEND has added three other species, viz. *A. tetragonurus*, *A. flavus*, and *A. macrurus*. Pending further information, *A. macrurus* seems to be a valid species on account of the very forward position of the clitellum (xv–xxii).

A. tetragonurus is probably, as ROSA thinks, merely a form of *Tetragonurus pupa*.

VAILLANT, in his work on the Oligochaeta (**6**, p. 151, &c.), allows five species, which are—

(1) **Allurus tetraedrus** (=*L. agilis*, HOFFM.), (SAV.).

(2) **Allurus amphisbaena** (DUG.).

(3) **Allurus phosphoreus** (DUG.).

(4) **Allurus brevicollis** (FITZ.).

(5) **Allurus brevispinus** (GERSTF.).

No. 3 has already been relegated to the genus *Pontodrilus* (see p. 472).

A. amphisbaena and *A. brevicollis* are probably referable to *Allurus*. As to the first it is usually regarded as a synonym of *A. tetraedrus*. But, as VAILLANT points out, the prostomium completely dividing the buccal lobe is in the way of this identification; so, too, is the size (?) 810 mm.[1] *A. brevicollis* has not paired setae, but in other respects seems to be probably referable to *Allurus*. *A. brevispinus* is very doubtful; there is no information as to clitellum or male pores.

It will be safest, in my opinion, to regard only two species as firmly established until further data are forthcoming. In this case the occasional presence of the male pores upon segment xv will be merely a variation.

(1) Allurus tetraedrus (SAVIGNY).

Enterion tetraedrum, J. C. SAVIGNY, Mém. Ac. Roy. Inst. Fr., 1826, p. 184.

Lumbricus tetraedrus, A. DUGÈS, Ann. Sci. Nat., 1837, pp. 17 and 23.

A. tetraedrus, G. EISEN, Öfv. svensk. Akad., 1874, No. 2, p. 54.

[1] ROSA gives 810 mm.; DUGÈS, 80 mm. The former measurement is very probably a printer's error.

L. agilis, HOFFMEISTER, Arch. f. Nat., 1843, p. 191.

L. Novae-Hollandiae[1], KINBERG, Öfv. Svensk. Akad., 1866, p. 99.

A. dubius, MICHAELSEN, JB. Hamb. wiss. Anst., vii, 1890, p. 7.

A. hercynius, MICHAELSEN, ibid., p. 7.

Definition. *Length,* 50 *mm.; number of segments,* 90. *Clitellum, XXII, XXIII–XXVII. Tubercula pubertatis a continuous band, XXIII–XXVI. Dorsal pores commence IV/V. Spermathecae in IX, X, opening to outside of seta IV. Hab.—Europe; S. America; Teneriffe; Australia; New Zealand.*

I follow ROSA (**15**) in the above synonymy; adding *A. hercynius.* No doubt several of the doubtful species mentioned on a previous page (p. 694) might also be added on equally good grounds as those shown by ROSA for including KINBERG'S '*Lumbricus novae-hollandiae.*'

The anatomy of this species has been studied by myself. But my results, which were based upon the examination of a specimen from Teneriffe, are not in all points in accord with those of other observers.

(2) Allurus neapolitanus.

Allurus neapolitanus, OERLEY, Ert. termesz. Kör. xv, 1885, p. 12.

Allolobophora ninnii, ROSA, Att. R. Ist. Venet., 1886, p. 680.

Allurus ninnii, ROSA, Mem. R. Acc. Torino, 1893, p. 73.

Definition. *Length,* 80 *mm.; number of segments,* 150. *Clitellum, XX, XXI–XXIV, XXV. Tubercula pubertatis, XXI–XXIV. Spermathecae in X, XI, opening anteriorly in line with seta IV. Hab.—Italy.*

Genus TETRAGONURUS, EISEN.

Syn. **Eisenia,** VAILLANT.

Allurus, MICHAELSEN.

DEFINITION. Male pores on segment XII. Clitellum, XVIII–XXII. Setae paired.

The genus contains only one well-defined species, viz.:—

Tetragonurus pupa, EISEN.

T. pupa, EISEN, Öfv. Svensk. Akad., No. 2, 1874, p. 47.

Lumbricus (Eisenia) pupa, VAILLANT, Annelés, p. 154.

[1] *Non* FLETCHER (see p. 700).

Allurus pupa, MICHAELSEN, JB. Hamb. wiss. Anst. vii, 1890, p. 10.
Eisenia pupa, BENHAM, Q. J. Micr. Sci., vol. xxxi, 1890, p. 266.
Allurus tetragonurus, FRIEND, Sci. Gossip., Nov. 1892, p. 243.

Definition. *Length, 30 mm.; number of segments, 85. Tubercula pubertatis on XIX, XX, XXI. Hab.—Canada; Wales.*

FRIEND'S specimen was the larger; EISEN gives 25 mm. as length, and counted forty segments. In '*Allurus tetragonurus*' the male pores are on xiii.

Genus ALLOLOBOPHORA, EISEN[1].

DEFINITION. Prostomium incompletely divides buccal lobe. Setae paired or more distant. Male pores on XV. No median seminal reservoirs.

The species of this genus vary chiefly in the position of the clitellum, tubercula pubertatis, and in the number and position of the spermathecae. But unfortunately the last-named organs are unknown in a considerable number of species. In those species in which they are known the number and position is given in the following table:—

I. Spermathecae absent.

A. constricta. *A. syriaca.*
A. eiseni. *A. samarigera.*

II. Spermathecae, two pairs.

(*a*) In ix, x.

(1) Opening near dorsal line.

A. foetida. *A. alpina.*
A. veneta.

(*b*) In x, xi.

(1) Opening near dorsal median line.

A. rosea.

(*c*) In ix, x.

(1) Opening in front of setae 3.

A. putris.

[1] The synonymy of many of the species of this genus is so confused and intricate that the following pages (nearly entirely derived from ROSA) claim to be no more than an approximation to a perfect arrangement.

(*d*) In x, xi.

(1) Opening in front of seta 3.

A. mammalis. *A. semetica.*

A. cyanea.

(2) Opening in front of dorsal pair.

A. caliginosa. *A. tellinii.*

A. icterica. *A. patriarchalis.*

(3) Opening in front of seta 4.

A. platyura. *A. byblica.*

A. georgii.

(*e*) In ix, x.

(1) Opening in front of dorsal pair of setae.

A. terrestris. *A. limicola.*

A. japonica. *A. jassyensis.*

A. smaragdina.

(*f*) In xii, xiii.

(1) Opening in front of dorsal setae.

A. festae.

(*g*) In viii, ix.

A. molleri.

III. Spermathecae, three pairs.

A. pygmaea. *A. octaedra.*

A. chlorotica.

IV. Spermathecae, five pairs.

A. transpadana.

V. Spermathecae, six pairs.

A. lissaensis. *A. mima.*

VI. Spermathecae, seven pairs.

A. gigas. *A. complanata.*

VII. Spermathecae, many pairs in a segment.

A. leoni. *A. savignyi.*

(1) Allolobophora caliginosa (Savigny).

Enterion caliginosum, Savigny, Mém. Ac. Roy. Inst. Fr. (Analyse), v, 1826, p. 180.
Lumbricus trapezoides, Dugès, Ann. Sci. Nat., xv, 1828, p. 291.
L. caliginosus, Dugès, Ann. Sci. Nat., (2) viii, 1837, p. 19.

L. communis, HOFFMEISTER, Arch. f. Nat., 1843, p. 188 (in part.).
A. turgida, EISEN, Öfv. Svensk. Akad., 1874, No. 2, p. 43.
A. trapezoides, ROSA, Att. R., Ist. Venet., 1886, p. 677.
L. novae-hollandiae, FLETCHER, P. Linn. Soc., N. S. W., 1886, p. 539.
L. (Allolobophora) caliginosus, VAILLANT, Annelés, p. 138.
L. (Allolobophora) trapezoideus, VAILLANT, Annelés, p. 139.
L. (Allolobophora) turgidus, VAILLANT, Annelés, p. 150.
A. caliginosa, ROSA, Boll. Mus. Zool. Torino, 1893, No. 160, p. 7.
? = **L. purus**, DUGÈS, Ann. Sci. Nat. (2), viii, 1837, p. 22.

Definition. *Length, 176 mm.; breadth, 4 mm.; number of segments, 248. Clitellum, XXVII, XXVIII–XXXIV, XXXV. First dorsal pore IX/X, rarely VIII/IX. Setae strictly paired. Tubercula pubertatis on XXXI and XXXIII. Spermathecae in X, XI, opening anteriorly on line with lateral setae. Hab.—Europe; America; Australia; Palestine; New Zealand.*

The synonymy of this species is complex; on the theory that *A. trapezoides* of DUGÈS and *A. turgida* of EISEN are distinct species, the latter may be with considerable reason placed with *L. caliginosus;* in both the tubercula are on xxx and xxxii, the intermediate segment being left out. It was this, indeed, which led ROSA (**15**, p. 5) to distinguish *A. turgida* from *A. trapezoides.* MICHAELSEN, however (**8**, p. 12), found an intermediate form which showed on one side of the body the character of one species, and on the other, the character of the other species. The position of the tubercula, characteristic of the present species, are also characteristic of *A. georgii* (see p. 716), *A. boeckii* (see p. 705), and '*Lumbricus purus*' of DUGÈS, in which there are two pairs of the tubercula as occasionally in the present species; these are said by VAILLANT (**6**, p. 126) to be on segments xxx and xxxii, which, interpreted for the enumeration used here, mean xxxi, xxxiii; the clitellum is nearly co-extensive with that of the present species, occupying segments xxviii–xxxiv. The identity of FLETCHER'S '*Lumbricus novae-hollandiae*' with the present has been pointed out by ROSA.

In the definition of the species I have followed ROSA (**15**).

I have received this species from New Zealand; the examples belonged to the subspecies *turgida* in that the tubercula pubertatis were upon xxxi and xxxiii.

(2) Allolobophora pygmaea, SAVIGNY.

Enterion pygmaeum, SAVIGNY, Mém. Ac. Roy. Inst. Fr. (Analyse), v, 1826, p. 183.
Lumbricus pygmaeus, DUGÈS, Ann. Sci. Nat., (2) viii, 1837, p. 22.

A. minima, Rosa, Lumbr. Piemont., 1884, p. 39.

Octolasion minimum, Oerley, Ert. termesz. Kör., xv, 1885, p. 22.

L. (Dendrobaena) pygmaeus, Vaillant, Annelés, p. 120.

A. pygmaea, Rosa, Mem. Acc. Torino, 1893, p. 40.

Definition. *Length, 13 mm.; diameter, 1 mm.; number of segments, 95. Setae distant. Clitellum, XXXIII–XXXVII. Tubercula pubertatis on XXXV, XXXVI, XXXVII. Male pores conspicuous. Spermatheca, three pairs, opening dorsally. Hab.—France; Austria; Italy.*

(3) Allolobophora gigas, Dugès.

Lumbricus gigas, Dugès, Ann. Sci. Nat., (2) viii, 1837, p. 290.

A. gigas, Oerley, Ert. termesz. Kör., xv, 1885, p. 25.

L. (Allolobophora) gigas, Vaillant, Annelés, p. 130.

Definition. *Length, 610 mm.; breadth, 17 mm.; number of segments, more than 300. Clitellum, XXX–LI. Setae strictly paired. Tubercula pubertatis, a ridge on each side occupying ten or thirteen segments. Spermathecae, seven pairs. Hab.—Italy; S. France.*

The enormous size of this species distinguishes it from all other European species. 720 mm. is given as the extreme length of the species; the measurement in the definition is taken from Vaillant.

(4) Allolobophora terrestris (Savigny).

Enterion terrestre, Savigny, Mém. Ac. Roy. Inst. Fr. (Analyse), 1826, v, p. 180.

Lumbricus terrestris, Dugès, Ann. Sci. Nat., (2) viii, 1837, p. 18.

Lumbricus agricola, Hoffmeister, Die bisj. bek. Art. Regenw., 1845, p. 5.

A. longa, Ude, Z. wiss. Zool., 1886, p. 136.

Definition. *Number of segments, 180. Clitellum, XXVI, XXVII–XXXV. Setae paired. Dorsal pores commence XII/XIII. Tubercula pubertatis on XXXII–XXXIV. Spermathecae, two pairs in IX, X, opening posteriorly in line with lateral setae. Hab.—Germany; England.*

The colour of this species is described by Ude as being brownish dark-grey in front, paler behind. On segments ix–xi, the ventral setae are borne upon papillae. The size and general appearance are stated by Ude to be as in *Lumbricus herculeus.* The identity of *A. longa* with the previously described '*Enterion terrestre*' is fully gone into by Rosa (15, p. 49), who is of opinion (15, p. 77) that *L. teres* may also

be the same species. *Lumbricus terrestris* of LINNAEUS being a compound of many species, I follow SAVIGNY.

(5) Allolobophora cyanea (SAVIGNY).

Enterion cyaneum, SAVIGNY, Mém. Ac. Roy. Inst. Fr. (Analyse), v, 1826, p. 181.
Lumbricus cyaneus, DUGÈS, Ann. Sci. Nat., (2) viii, 1837, p. 21.
A. studiosa, MICHAELSEN, Arch. Ver. Nat. Meckl., 1890, p. 50.

Definition. *Length,* 120 *mm.; breadth,* 7 *mm.; number of segments,* 156. *Clitellum, XXIX–XXXIV. Tubercula pubertatis on XXX–XXXIII. Setae not strictly paired; the distance between* 1 *and* 2 *is greater than that between* 3 *and* 4; *anteriorly, the setae are closer together. First dorsal pore, XI/XII. Spermathecae in X, XI, opening between IX/X, X/XI, provided with diverticula larger than pouch extending into segment in front. Hab.—Europe; Argentina.*

The colour is dirty grey, anteriorly pale violet; the distances between the setae are thus given by MICHAELSEN:—'iv–iv=i–i; i–i > i–ii > ii–iii > iii–iv;' anteriorly, 'i–ii < ii–iii > iii–iv.' It is stated that the diverticula resemble those of *A. complanata* (see BEDDARD, **13**).

(6) Allolobophora mammalis (SAVIGNY).

Enterion mammale, SAVIGNY, Mém. Ac. Roy. Inst. Fr. (Analyse), v, 1826, p. 181.
Lumbricus mammalis, DUGÈS, Ann. Sci. Nat., (2) viii, 1837, p. 22.
A. celtica, ROSA, Boll. Mus. Zool. Torino, 1886, No. 2.
L. (Allolobophora) mammalis, VAILLANT, Annelés, p. 148.
A. (Dendrobaena) celtica, FRIEND, J. Linn. Soc., 1892, p. 297.

Definition. *Length,* 40 *mm.; breadth,* $2\frac{1}{2}$ *mm.; number of segments,* 100. *Clitellum, XXXI–XXXVI. First dorsal pore. Tubercula pubertatis on XXXIII, XXXIV. Setae in eight rows, the intervals increasing from below upward. Hab.—Brittany; England; Scotland.*

This species shows that remarkable alternation in the position of the nephridiopores which is characteristic of other species of the genus, and which has already been dealt with.

(7) Allolobophora foetida (SAVIGNY).

Enterion foetidum, SAVIGNY, Mém. Ac. Roy. Inst. Fr. (Analyse), v, 1826, p. 182.
Lumbricus annularis, TEMPLETON, Mag. Nat. Hist., vol. ix, 1836, p. 234.

L. foetidus, DUGÈS, Ann. Sci. Nat., (2) viii, 1837, p. 21.

L. olidus, HOFFMEISTER, De Verm. Quib., 1842, p. 24.

L. brevispinus, GERSTFELDT, Mém. Sav. Etrang. Ac. St. Pétersb., viii, 1859, p. 269.

Allolobophora foetida, EISEN. Öfv. Svensk. Akad., 1873, No. 8, p. 50.

L. (Allolobophora) foetida, VAILLANT, Annelés, p. 147.

Definition. *Length*, 90 *mm.; breadth*, 4 *mm.; number of segments*, 105. *Clitellum, XXV, XXVII–XXXII. Setae strictly paired. First dorsal pore, IV/V. Tubercula pubertatis, XXVIII–XXXI. Spermathecae, two pairs in IX, X, opening posteriorly, very dorsal in position. Hab.—Europe; America; Asia, &c. (universally distributed).*

This species has a very characteristic coloration; the ground colour is a flesh tint marked in each segment by a ring of purplish.

(8) Allolobophora chlorotica (SAVIGNY).

Enterion chlorotioum, SAVIGNY, Descr. Egypte, t. xxii.

E. virescens, SAVIGNY, ibid.

Lumbricus anatomicus, DUGÈS, Ann. Sci. Nat., xv, 1828, p. 292.

L. chloroticus, DUGÈS, Ann. Sci. Nat., (2) viii, 1837, p. 19.

L. riparius, HOFFMEISTER, Arch. f. Nat., 1843, p. 189.

L. viridis, JOHNSTON, Cat. Worms, 1865, p. 60.

Allolobophora riparia, EISEN, Öfv. Svensk. Akad., 1873, No. 8, p. 46.

A. neglecta, ROSA, Att. Acc. Torino, 1882, p. 170.

A. chlorotica, VEJDOVSKY, Syst. u. Morph., 1884, p. 60.

Aporrectodea chlorotica, OERLEY, Ert. termesz. Kör., 1885, p. 22.

A. (A.) chlorotica, ROSA, Boll. Mus. Zool. Torino, 1890, No. 160.

Definition. *Length*, 100 *mm.; number of segments*, 100. *Clitellum, XXIX, XXX–XXXVII. First dorsal pore, IV/V. Setae paired, but not so close as in* A. turgida. *Tubercula pubertatis on XXXI, XXXIII, XXXV. Spermathecae, three pairs in IX–XI, opening on to VIII/IX, IX/X, X/XI, in line with lateral setae. Hab.—Europe; Azores; Palestine.*

This species is to be also recognized by its green colour, which does not appear to be so bright as in *A. smaragdina*. Coloured figures are to be found in the works of EISEN, HOFFMEISTER, and D'UDEKEM. EISEN'S figures include his two varieties, '*pallescens*' (=var. *A. anatomica*, ROSA) and '*rufescens*.' ROSA has recorded a yellow or flesh-coloured variety from Treviso. The worm, when annoyed, gives out a yellow or green fluid, from dorsal pores, which is inodorous. I imagine that the above synonymy is more likely to be accurate than that of other species,

owing to the generally marked colour of the worm, and its habit, alluded to by HOFFMEISTER and D'UDEKEM, of bending into a circle when touched. Anatomically, it differs by the presence of three spermathecae. In *A. neglecta* (later regarded by ROSA as merely a variety) there are four or five pairs of tubercula on xxxi–xxxv.

(9) Allolobophora complanata (DUGÈS).

Lumbricus complanatus, DUGÈS, Ann. Sci. Nat., xv, 1828, p. 292.
A. complanata, ROSA, Lumbr. Piemont., 1884, p. 40.
L. (Dendrobaena) complanatus, VAILLANT, Annelés, p. 117.
A. (Octolasion) complanata, ROSA, Boll. Mus. Zool. Torino, 1893, No. 160, p. 9.

Definition. *Length,* 180 *mm.; diameter,* 10 *mm.; number of segments,* 190. *Clitetlum, XXVIII–XXXVII. Setae distant, the intervals diminishing from below upwards. First dorsal pore, XI/XIII. Tubercula pubertatis in the form of two lines on clitellar segments. Spermathecae, seven pairs in VI–XII. Hab.—Mediterranean district (including Palestine and Algeria).*

The above definition has been taken from ROSA'S description of the species, excepting only as regards the first dorsal pore, which ROSA found to be between segments xiii/xiv, a little behind the position assigned to it by UDE. The anatomy of this worm has been investigated by DUGÈS, ROSA (**19**), UDE (**3**), and by myself (**13**). The spermathecae lie often partly in one segment and partly in the following or the preceding segment, as was first pointed out by myself; this character, however, is mentioned neither by DUGÈS nor ROSA; MICHAELSEN has found a similar state of affairs in *A. studiosa.* The sperm-sacs, are remarkably intermediate in character between those of the typical *Allolobophora* on the one hand, and those of a *Lumbricus* on the other.

(10) Allolobophora norvegica, EISEN.

A. norvegica, EISEN, Öfv. Svensk. Akad., 1873, No. 8, p. 48.
Lumbricus norvegicus, LEVINSEN, Vid. Med., 1883, p. 243.
L. (Allolobophora) norvegicus, VAILLANT, Annelés, p. 143.

Definition. *Length, about* 100 *mm.; number of segments,* 120. *Setae strictly paired. Clitellum, XXVI–XXXII. Tubercula pubertatis on XXVIII, XXIX, XXX, XXXI. Hab.—Norway.*

This is another uncertain species, coming so near to *A. nordenskiöldii* that, if they had not been both described by the same writer, I should have been disposed to put them down as identical.

(11) Allolobophora tumida, Eisen.

A. tumida, Eisen, Öfv. Svensk. Akad, 1874, No. 2, p. 45.

Definition. *Length, about* 30 *mm.; number of segments,* 50. *Colour reddish brown. Setae paired at four angles of quadrangular body. Clitellum, XXII–XXIX. Tubercula pubertatis, XXVII, XXVIII. Hab.—New England; Denmark* (?)[1].

There is no doubt that Rosa's suggestion as to the possibility of this worm being an *Allurus* is reasonable.

(12) Allolobophora parva, Eisen.

A. parva, Eisen, Öfv. Svensk. Akad., 1874, No. 2, p. 46.

Lumbricus parvus, Tauber, Ann. Dan., 1879, p. 68.

Definition. *Length, about* 100 *mm.; number of segments, about* 100. *Setae paired closely, but dorsal more so than ventral. Clitellum, XXIV–XXX. Tubercula pubertatis, XXV–XXX. Hab.—New England, Denmark*[2].

(13) Allolobophora eiseni (Levinsen).

Lumbricus Eiseni, Levinsen, Vid. Med., 1883, p. 241.

A. (Dendrobaena) Eiseni, Friend, J. Linn. Soc., 1892, p.302.

A. Eiseni, Rosa, Mem. R. Acc. Torino, 1893, p. 66.

Definition. *Length,* 40 *mm.; diameter,* 4 *mm.; number of segments,* 110. *Colour iridescent violet above, red-brown on clitellum. Setae strictly paired. Clitellum, XXIV, XXV–XXXII. Tubercula pubertatis, none. First dorsal pore, V/VI. Spermathecae absent. Sperm-sacs in XI, XII. Hab.—Europe generally.*

(14) Allolobophora boeckii (Eisen).

Lumbricus puter, Eisen, Öfv. Svensk. Akad., 1870, No. 10, p. 959.

Dendrobaena Boeckii, Eisen, ibid., 1873, No. 8, p. 53.

D. puter, Oerley, MT. Akad. Math., xvi, 1880, p. 586.

[1] *Fide* Tauber; but Levinsen distrusts the latter's identification.

[2] Levinsen doubts Tauber's identification.

Lumbricus Boeckii, TAUBER, Ann. Dan., 1879, p. 69.

D. Camerani, ROSA, Att. Acc. Torino, 1882, p. 172.

Dendrobaena rubida, VEJDOVSKY, Syst. u. Morph., 1884, p. 60.

A. Boeckii, ROSA, Lumbr. Piemont., 1884, p. 48.

Octolasion Boeckii, OERLEY, Ert. temesz. Kör., xv, 1885, p. 20.

A. (Dendrobaena) Boeckii, FRIEND, J. Linn. Soc., 1892, p. 298.

Definition. *Length, 35 mm.; number of segments, 95. Clitellum, XXIX–XXXIII, XXXIV Setae distant. Tubercula pubertatis on XXXI–XXXIII. Hab.—Europe.*

It might appear from the above synonymy that the name of the species should be '*puter;*' but EISEN himself pointed out that his *Lumbricus puter* was not the same species as HOFFMEISTER'S *Lumbricus puter*: both VEJDOVSKY and KULAGIN (**3**, p. 94) regard *Lumbricus rubidus* of DUGÈS (**1**) as a synonym of the present species. VEJDOVSKY remarks upon this question (**24**, p. 60), 'Unbegreiflicher Weise legt HOFFMEISTER *Ent. rubidum* als Synonym zu seinem *Lumbricus olidus*, was ich nur aus dem Umstande erkläre, dass er, wie er erwähnt, nur die in Weingeist konservirten Savigny'schen gürtellosen Typen vergleichen konnte. Allein die schon von DUGÈS gegebene Beschreibung von seinem *Lumbricus rubidus* zeugt, dass diese Art mit *Lumbricus puter*, HOFFM. identisch ist. DUGÈS sagt nämlich, pag. 23: "Du reste il y a aussi de bandelettes (tubercula pubertatis, EISEN) sous le trentième, trent et unième, et trent deuxième anneaux . . . Ce qui le distingue surtout, ce sont les rangées de soies très écartées les unes des autres, quoique réellement géminées."' VEJDOVSKY, however, has overlooked another point in the description of the species, and that is the position of the spermathecae, which open close to the dorsal median line. This character is evidence of the species being really *Lumbricus olidus* of HOFFMEISTER (=*A. foetida*), or perhaps *A. veneta* of ROSA, which was not, as a matter of fact, described at the time when VEJDOVSKY wrote. ROSA certainly says nothing about the spermathecae of *Allolobophora boeckii;* neither does EISEN; but ROSA places it in his fourth group of *Allolobophora*, which is characterized by the fact that these organs open in line with the third seta. VEJDOVSKY finds but one pair, concerning the exact position of the orifice of which he says nothing. The setae too of *Allolobophora boeckii*, although they resemble those of HOFFMEISTER'S species in being in four rows, are really different in their arrangement; and are, according to ROSA, sufficient in themselves to identify the species. The lateral spaces are nearly equal, but decrease slightly from below upwards. These spaces are so large that the dorsal space is only twice the width of the superior lateral space; the ventral space is smaller than the dorsal and is only a little wider than the inferior lateral space.

(15) Allolobophora subrubicunda, Eisen.

A. subrubicunda, Eisen, Öfv. Svensk. Akad., 1873, No. 8, p. 51.
A. arborea, Eisen, ibid., p. 47.
A. tenuis, Eisen, ibid., 1874, No. 2, p. 44.
Lumbricus subrubicundus, Levinsen, Vid. Med., 1883, p. 242.
Octolasion subrubicundum, Oerley, Ert. termesz. Kör., xv, 1885, p. 20.
A. putris Hoffm. forma subrubicunda Eisen, Michaelsen, JB. Hamb. wiss. Anst., viii, 1891, p. 18.
L. (Allolobophora) subrubicundus, Vaillant, Annelés, p. 143.
L. (Allolobophora) tenuis, Vaillant, Annelés, p. 144.
L. (Allolobophora) arboreus, Vaillant, Annelés, p. 149.
A. putris, Michaelsen, Arch. Ver. Nat. Meckl., 1890, p. 49 (? in part.).
A. subrubicunda, formae typica et arborea, Michaelsen, JB. Hamb. wiss. Anst., vii, 1890, p. 15.
A. (Dendrobaena) subrubicunda, Friend, J. Linn. Soc., 1892, p. 29.
A. (Dendrobaena) arborea, Friend, ibid., p. 301.
? = **L. puter**, Hoffmeister et Alii.
? = **A. Fraissei**, Oerley, Zool. Anz., 1881, p. 285.

Definition. *Length, 75 mm.; breadth, 0·4 mm.; number of segments,* 110. *Clitellum, XXVI–XXXI. First dorsal pore V/VI. Setae paired, but not closely. Tubercula pubertatis on XXVIII–XXX. Spermathecae, one pair in X, opening in line with lateral setae. Hab.—Europe; Azores; N. America; Patagonia.*

This is another species with a complex synonymy. Eisen united his two species, *A. tenuis* and *A. arborea*, which were formerly held to be distinct, after the examination of a larger number of specimens; in the same paper he further said: 'Some of the specimens (of *A. tenuis*) . . . also show a swelling on the twenty-seventh (twenty-eighth) segment, which might be mistaken for a tuberculum pubertatis, and which also indicates the relation to the preceding species, *A. subrubicunda*, but with which it never occurs.' Levinsen has placed all three together under the name '*subrubicundus*,' a position which Michaelsen has also taken up. Michaelsen, however, distinguishes the three supposed species as three 'forms' of one species; he has added to these the species '*constricta*' of Rosa, and a new form '*hortensis*'; the former is described in the present work as a distinct species, and

the latter has been shown by ROSA to be a variety of his *A. veneta*. It will be noticed, therefore, under the description of that species.

The fact that this species has only a single pair of spermathecae, is a point of resemblance to *A. boeckii*, with which, indeed, it may have been partly identified by VEJDOVSKY, since he places among the synonyms of his *Dendrobaena rubida* both *A. boeckii* and *Lumbricus puter* of HOFFMEISTER, which ROSA and others regard as probably a synonym of the present species. These two species differ markedly in the position of the clitellum and the tubercula pubertatis.

I have not included in the list of synonyms of this species *Enterion rubidum* of SAVIGNY, ROSA (**15**, p. 76); though regarding it as 'species inquirenda,' and as not corresponding perfectly to *A. putris*, thinks that it is probably the same.

(16) Allolobophora icterica, ROSA.

A. icterica, ROSA, Att. R. Ist. Venet., 1886, p. 685.

? = **Enterion ictericum**, SAVIGNY, Mém. Ac. Roy. Inst. Fr. (Analyse), v, 1826, p. 183.

Definition. *Length, 80 mm.; breadth, 5 mm.; number of segments, 190. Clitellum, XXXIV–XLIV. Setae strictly paired. Tubercula pubertatis forming a ridge along clitellar segments. Spermathecae in X, XI, opening anteriorly in line with outer setae. Hab.—Italy.*

ROSA, who has described the species, identifies it with inconsiderable doubt with SAVIGNY'S *Enterion ictericum*. This identification depends chiefly upon the similar position and extent of the clitellum, which is only paralleled in *A. gigas* and *A. dubiosa*. None of the two later species can be confounded with *E. ictericum*, as they have not paired setae.

The principal difference between SAVIGNY'S *E. ictericum* and the species called *A. icterica* by ROSA, is that the former has four pairs of spermathecae. ROSA, however, states that in his species one individual had the two pairs of spermathecae doubled. Something of the same kind may possibly account for the 'four' pairs of spermathecae in SAVIGNY'S species.

(17) Allolobophora hispanica, UDE.

A. hispanica, UDE, Z. wiss. Zool., 1886, p. 135.

Definition. *Number of segments, 220. Clitellum, XXIX–XLIII. Setae paired. First dorsal pore, XII/XIII. Tubercula pubertatis on all the clitellar segments (?). Hab.—Spain.*

The colour of this species (which has the size of *Lumbricus herculeus*) is a dirty brown dorsally, greyer in front, and paler behind; the clitellum is yellowish. The setae behind the clitellum appear to be larger than those in front. UDE has said nothing about the spermathecae.

(18) Allolobophora molleri, ROSA.

A. molleri, ROSA, Boll. Mus. Zool. Torino, 1889, No. 63.

Definition. *Length, 150 mm.; breadth, 4 mm.; number of segments, 210. Dorsal pores commence IV/V. Tubercula pubertatis on L–LVII. Setae strictly paired. Spermathecae in VIII, IX, opening between VII/VIII, VIII/IX, in line with dorsal setae. Hab.—Portugal.*

This species comes nearest to *A. trapezoides* and *A. chlorotica*, but is very distinct from both, not only in the position of the spermathecae, but also in other points. The colour of the living worm is very characteristic: the ground colour is rose, which passes dorsally into a greenish, but in the posterior region of the body the entire worm is of an intense green, which has even a tinge of blue. The clitellum was not developed, but doubtless lies in the neighbourhood of the segments occupied by the tubercula pubertatis. There are papilla-like convexities on xii–xiv, and sometimes also xx, which bear the ventral setae. The male pores (on the fifteenth segment) are connected with longitudinal ridges, which reach back to the tubercula.

(19) Allolobophora tellinii, ROSA.

A. Tellinii, D. ROSA, Boll. Mus. Zool. Torino, 1888, No. 44.

Definition. *Length, 500 mm.; breadth, 15 mm.; number of segments, 264. Clitellum, XXV, XXVI, XXVII–XLI. First dorsal pore, V–VI. Setae paired, those of dorsal pairs more strictly paired. Tubercula pubertatis on XXXII–XXXVII. Spermathecae in X, XI, opening between IX/XI, XI/XII. Hab.—Italy.*

This species is one of the largest of the genus; it was found at an altitude of 220 m.; its colour is whitish, with a brownish-purple band on each segment. The setae (ventral) of segments viii–xii borne upon glandular papillae. There appear to be only two pairs of sperm-sacs in xi, xii.

(20) Allolobophora transpadana, ROSA.

A. transpadana, ROSA, Lumbr. Piemont., 1884, p. 45.

Octolasion transpadanum, OERLEY, Ert. termesz. Kör., xv, 1885, p. 19.

Lumbricus terrestris, var. stagnalis, OERLEY, Mt. Akad. Math., 1880, p. 583.
? = **Enterion opimum,** SAVIGNY, Mém. Ac. Roy. Inst. Fr. (Analyse), v, 1826, p. 183.
[**Unnamed worm**], HORST, Notes Leyd. Mus., 1887, p. 297.

Definition. *Length,* 90 *mm.; diameter,* 5 *mm.; number of segments,* 155. *Clitellum, XXIX, XXX, XXXVII. Setae, as in* A. complanata. *Dorsal pores commence XI/XII. Tubercula pubertatis, forming two lines on all of clitellar segments. Spermathecae, five pairs in VI-VIII, X, XI. Hab.—Italy.*

This species has been chiefly studied by ROSA. BORELLI has shown that the nephridia alternate in the same way that they do in other species. The spermathecae have a curious arrangement; the first three open by the posterior septum of their segments; the fourth opens by the septum ix/x; the fifth by the septum x/xi. The colour is earthy brown, like *A. complanata,* perhaps more yellowish in the middle of the body. ROSA has described a variety from the neighbourhood of Venice, which is distinguished by its colour and smaller size; the colour is greyish, with a bluish tinge, rose anteriorly, and reddish at the posterior end; this coloration is stated by ROSA to be identical with that of *A. profuga. Enterion opimum* of SAVIGNY is stated to have only four pairs of spermathecae.

(21) Allolobophora alpina, ROSA.

A. alpina, ROSA, Lumbr. Piemont., 1884, p. 28.
A. (Notogama) alpina, ROSA, Boll. Mus. Torino, 1890, No. 160, p. 3.

Definition. *Length,* 50 *mm.; number of segments,* 130. *Clitellum, XXVII, XXVIII–XXXII, XXXIV. Setae distant. Tubercula pubertatis on XXX-XXXII. Spermathecae in IX, X, opening on to IX/X, X/XI, near to dorsal line. Hab.—Italy; Palestine.*

This species is like *A. foetida, A. veneta,* and perhaps also *A. rubida,* in the position of the spermathecal pores.

(22) Allolobophora festae, ROSAE.

A. festae, ROSA, Boll. Mus. Zool. Torino, 1892, No. 122.

Definition. *Length,* 35 *mm.; breadth,* 2 *mm.; number of segments,* 180. *Clitellum, XX, XXI–XXXIII. Tubercula pubertatis on XXIX–XXXI. Setae strictly paired. Spermathecae, two pairs in XII, XIII (?), opening by dorsal setae. Hab.—Tunis.*

This species is characterized by the above definition; the account given by Rosa deals with but few points, besides those mentioned in the definition; it is not quite clear from his description whether the spermathecae are in segments xii and xiii or in xiii and xiv; he merely says that the external opening is on the line between segments xii and xiii and xiii and xiv; the shape of these organs appears to be characteristic; they are described as being 'claviformi, molto allungati.' There are special accessory papillae upon segments xvi and xxvi, which bear the ventral setae; the last pair are not so constant as the first, and are connected by a raised transverse ridge.

(23) Allolobophora smaragdina, Rosa.

A. smaragdina, Rosa, Boll. Mus. Zool. Torino, 1872, No. 130.

Definition. *Length,* 80 *mm.; breadth,* 6 *mm.; number of segments,* 104. *Clitellum, XXIV, XXV–XXXIII. First dorsal pore, IV/V. Tubercula pubertatis on XXX–XXXII. Setae paired, ventral in position. Spermathecae, two pairs in IX/X, opening IX/X, X/XI, in line with dorsal setae. Hab.—Bleiberg, Carinthia; at* 1000 *m.*

The most noticeable character of this species, when alive, was the bright green colour, which, as Rosa observes, is a rare colour among earthworms. The colour seems to be like that of *A. molleri, Microchaeta rappii,* and a *Benhamia* referred to above (p. 559). The sperm-sacs are four pairs in ix–xii, without any median sperm-reservoir.

(24) Allolobophora constricta, Rosa.

A. constricta, Rosa, Lumbr. Piemont., 1884, p. 38.

A. subrubicunda forma constricta, Michaelsen, JB. Hamb. wiss. Anst., vii, 1890, p. 15.

Definition. *Length (in alcohol),* 20 *mm., when alive up to* 45 *mm.; number of segments,* 100. *Clitellum, XXVI–XXXI. Setae paired but not strictly. No tubercula pubertatis. No spermathecae. Hab.—Italy.*

The reasons which led Michaelsen to regard this species as at most a variety of *A. subrubicunda* were the variability in the tubercula pubertatis coupled, of course, with the other points of agreement, such as small size and position of the clitellum. Out of twenty-two specimens of *A. subrubicunda* collected, fourteen belonged to the variety '*constricta*'; the rest were intermediate in characters. The first lot had no trace of tubercula, and were partly mature and partly immature to some extent;

the fully ripe ones had spermatophores attached to the body. The other eight showed traces of tubercula on segments xxix, xxx. Unfortunately MICHAELSEN made no mention of the presence or absence of spermathecae, which would have decided the question; until accurate information is forthcoming that the spermathecae are missing frequently in the typical *A. subrubicunda*, I think it necessary to retain ROSA's species *A. constricta*.

(25) Allolobophora profuga, ROSA.

Lumbricus terrestris, var. lacteus, OERLEY, Mt. Akad. Math., xvi, 1880, p. 584.

A. profuga, ROSA, Lumbr. Piemont., 1884, p. 47.

Octolasion profugum, OERLEY, Ert. termesz. Kör., xv, 1885, p. 17.

O. lacteum, OERLEY, ibid., p. 21.

A. cyanea, ROSA, Mem. R. Acc. Torino, 1893, p. 59 (in part.).

?=**Lumbricus stagnalis,** HOFFMEISTER, Die bisj. bek. Art. Regenw. 1845, p. 35.

Definition. *Length, about* 60 *mm.; diameter,* 3 *mm.; number of segments,* 165. *Clitellum, XXX–XXXV. Setae as in* A. complanata. *Tubercula pubertatis, XXXI–XXXIV. Spermathecae, two pairs in X, XI, opening in line with third setae, between IX/X, X/XI. First dorsal pore, X/XI or XI/XII. Hab.—Italy; Germany; Spain; Argentine.*

This species has been described by ROSA and by UDE; the descriptions of these two writers differ in some small points; in others the observations of UDE supplement those of ROSA. In the definition of the species I have followed ROSA, only adding to the facts given by him the position of the first dorsal pore, not mentioned by ROSA, but referred to by UDE. UDE's specimens were rather larger, measuring up to 150 segments. The clitellum is a little more extensive, extending over segments xxix, xxx–xxxv[1]; the tubercula pubertatis form a groove which reaches from the middle of segment xxx to the middle of segment xxxv. The position of the first dorsal pore varies from x/xi to xi/xii. On the authority of UDE I add (as he did doubtfully) *Lumbricus stagnalis* of HOFFMEISTER as a synonym. I do not, however, see any grounds for this identification; '*Lumbricus stagnalis*' does seem to belong to this section of *Allolobophora*, but it might also be *A. veneta*—indeed the extent of the clitellum is more suggestive of this species. ROSA mentions that this species has the same odour of garlic that characterizes *A. complanata* and *A. transpadana*; from the anterior segments it emits a colourless fluid, and, after the fifteenth, a yellow fluid. This species is said by ROSA to have bilobed spermathecae.

[1] ROSA (15, p. 60) thinks that UDE had both this species and *A. studiosa* (which ROSA unites) in his hands at the time that he wrote the description.

(26) Allolobophora veneta, Rosa.

A. veneta, Rosa, Boll. Mus. Zool. Torino, 1886, No. 3.

A. subrubicunda, forma hortensis, Michaelsen, J. B. Hamb. wiss. Anst., vii, 1890, p. 15.

A. (Notogama) veneta, Rosa, Boll. Mus. Zool. Torino, 1893, No. 160, p. 2.

A. hibernica, Friend, P. R. Irish Ac., 1893, p. 402.

Definition. *Length,* 70 *mm.; breadth,* 5 *mm.; number of segments,* 153. *Clitellum, XXVI, XXVII–XXXII, XXXIII. Setae paired but not strictly, the setae of ventral pair more separated than those of dorsal pairs. Tubercula pubertatis on XXX, XXXI. Spermathecae, two pairs in IX, X, opening posteriorly. Hab.—Venice ; Argentina ; Portugal ; Palestine.*

The species comes very near to *A. foetida*, with which it agrees absolutely in colour. It is to be distinguished by the position of the tubercula pubertatis. The spermathecae open close to the dorsal middle line as in the species mentioned. The Portuguese specimens form a variety which is marked by its smaller size and by the more strictly paired setae. This same variety is found in Liguria and in the Argentine (whither it has been probably accidentally imported). It is not certain whether *A. submontana* of Vejdovsky is really different. The clitellum seems to have a different position (i. e. xxiv–xxxiii), but the structure of the worm is not fully known.

(27) Allolobophora syriaca, Rosa.

A. syriaca, Rosa, Mem. R. Acc. Torino, 1893, p. 65.

Definition. *Length,* 130 *mm.; diameter,* 9 *mm.; number of segments,* 210. *Setae distant:* 1–2 = 3–4, *both* > 2–3. *Clitellum, XXVI–XXXII. Tubercula pubertatis,* $\overline{XXVII\text{–}XXXI}$. *Dorsal pores commence IV/V or V/VI. Sperm-sacs two pairs in XI, XII. Spermathecae absent. Hab.—Samsun in Asia Minor.*

Three examples of this species from the Imperial Museum at Vienna were studied by Rosa, who adopted Carl Wesseley's MS. name.

(28) Allolobophora mima, Rosa.

A. mima, Rosa, Boll. Mus. Zool. Torino, 1889, No. 63.

Definition. *Length,* 240 *mm.; diameter,* 12 *mm.; number of segments,* 260. *Setae distant,* 1–2 = 2–3 > 3–4. *Clitellum, XXVIII (XXIX)–XL (XLI). Tubercula pubertatis,*

XXVIII (XXIX–XL), XLI. Dorsal pores commence XIII/XIV. Spermathecae in VI–XI, opening posteriorly in line with seta 3. *Hab.—Italy and South Austria.*

(29) Allolobophora samarigera, Rosa.

A. (Dendrobaena) samarigera, Rosa, loc. cit., p. 5.

Definition. *Length,* 80 *mm.; diameter,* 9 *mm.; number of segments,* 140. *Setae distant. Clitellum, XXVIII–XXXIV. Tubercula pubertatis absent. First dorsal pore, IV/V. Sperm-sacs in IX, XI, XII. No spermathecae. Hab.—Palestine.*

(30) Allolobophora patriarchalis, Rosa.

A. patriarchalis, Rosa, loc. cit., p. 9.

Definition. *Length,* 75 *mm.; diameter,* 5 *mm.; number of segments,* 160. *Setae strictly paired. Clitellum, XXII–XXXIII. Tubercula pubertatis, XXXI, XXXII. First dorsal pore, IV/V. Sperm-sacs in XI, XII. Spermathecae in X, XI, opening anteriorly by dorsal seta. Hab.—Palestine.*

(31) Allolobophora semitica, Rosa.

A. (Dendrobaena) semitica, Rosa, loc. cit., 1893, No. 160, p. 3.

Definition. *Length,* 70 *mm.; diameter,* 7 *mm.; number of segments,* 140. *Setae distant. Clitellum, XXVI–XXXIII. Tubercula pubertatis, XXXI, XXXII (XXXIII). First dorsal pore, V/VI. Sperm-sacs in IX, XI, XII. Spermathecae in X, XI, opening anteriorly in line with seta* 3. *Hab.—Palestine.*

(32) Allolobophora byblica, Rosa.

A. (Dendrobaena) byblica, Rosa, loc. cit., p. 4.

Definition. *Length,* 40 *mm.; diameter,* 4 *mm.; number of segments,* 100. *Setae distant. Clitellum, XXV–XXX. Tubercula pubertatis on XXVI–XXVIII. Dorsal pores commence X/XI. Sperm-sacs in IX, XI, XII. Spermathecae in X, XI, opening anteriorly in line with seta* 4. *Hab.—Palestine.*

(33) Allolobophora rosea (Savigny).

Enterion roseum, Savigny, Mém. Ac. Roy. Inst. Fr. (Analyse), v, 1826, p. 182.
Lumbricus roseus, Dugès, Ann. Sci. Nat., (2) viii, 1837, p. 20.

L. communis, HOFFMEISTER, Die bisj. bek. Art. Regenw., 1845, p. 27 (in part.).
A. mucosa, EISEN, Öfv. Svensk. Acad., 1874, No. 2, p. 47.
L. aquatilis, VEJDOVSKY, SB. Böhm. Ges., 1875, p. 199.
L. mucosus, TAUBER, Ann. Dan., 1879, p. 16.
A. carnea, VEJDOVSKY, Syst. u. Morph., 1884, p. 61.
A. aquatilis, OERLEY, Ert. termesz. Kör., xv, 1885, p. 28.
L. (Allolobophora) carneus, VAILLANT, Annelés, p. 136.
L. (Allolobophora) roseus, VAILLANT, Annelés, p. 137.
A. rosea, ROSA, Mem. R. Acc. Torino, 1893, p. 31.
A. (Notogama) rosea, ROSA, Boll. Mus. Zool. Torino, 1893, No. 160, p. 2.

Definition. *Length*, 60 *mm.; diameter*, 4 *mm.; number of segments*, 150. *Setae strictly paired. Clitellum, XXV (XXVI)–XXXII. Tubercula pubertatis, XXIX–XXXI (XXIX, XXX). Dorsal pores begin IV, V. Spermatheca in X, XI, opening anteriorly near to middle dorsal line. Hab.—Europe; Palestine; Siberia; Morocco; N. America; Argentine; Brazil.*

The above definition refers to the 'subspecies *typica*' of ROSA. A second subspecies is '*macedonica*,' with a clitellum xxvi–xxxiii, from Macedonia.

(34) Allolobophora nordenskioldii, EISEN.

A. Nordenskiöldii, EISEN, K. Svensk. Akad. Handl., 1879, No. 7, p. 6.
Lumbricus (Allolobophora) Nordenskioeldii, VAILLANT, Annelés, p. 146.

Definition. *Length*, 150 *mm.; number of segments*, 125. *Setae strictly paired. Clitellum, XXVI–XXXII. Tubercula pubertatis, XXIX, XXX, XXXI. Hab.—Siberia; Sweden; Azores.*

This species appears to be coloured like *A. foetida*, and, according to ROSA (**15**), has an identical ornamentation upon the seta. The two are doubtfully distinct.

(35) Allolobophora hermanni, MICHAELSEN.

A. Hermanni, MICHAELSEN, JB. Hamb. wiss. Anst., vii, 1890, p. 13.

Definition. *Length*, 40 *mm.; breadth*, 2 *mm.; number of segments*, 100. *Tubercula pubertatis on XXIX, XXX. First dorsal pore IV/V. Setae are paired, though the two setae of each pair are more widely separated in anterior segments; these setae also are larger than those which follow. Hab.—Harz Mountains; in a morass.*

This species appears to be without integumental pigment.

(36) Allolobophora georgii, Michaelsen.

A. Georgii, Michaelsen, JB. Hamb. wiss. Anst., vii, 1890, p. 3.

Definition. *Length,* 29 *mm.; breadth,* $2\frac{1}{2}$ *mm.; number of segments,* 110. *Clitellum, XXVIII, XXIX–XXXV. First dorsal pore IV/V. Tubercula pubertatis on XXXI, XXXIII. Setae strictly paired. Spermathecae in X, XI, opening between IX/X, X/XI, in line with seta* 4. *Hab.—Valencia, Spain.*

This species comes nearest to *A. trapezoides.*

(37) Allolobophora limicola, Michaelsen.

A. limicola, Michaelsen, loc. cit., vii, 1890, p. 10.

Definition. *Length,* 90 *mm.; breadth,* 4 *mm.; number of segments,* 127. *Clitellum, XXIX–XXXV. First dorsal pore IV/V. Tubercula pubertatis on XXXIII and XXXIV. Setae paired, the lateral closer together than the ventral. Spermathecae, two pairs in IX, X, opening on to IX/X, X/XI, in line with dorsal setae. Hab.—Hamburg; in a morass.*

The worm when alive is transparent, and flesh-coloured in front; behind it is almost colourless. The ventral setae of segments xxx–xxxii, xxxv, stand in some specimens upon papillae; in addition to these there are often conspicuous papillae upon segments ix, xii, occupying the space between the dorsal and ventral setae.

(38) Allolobophora antipae, Michaelsen.

A. Antipae, Michaelsen, loc. cit., viii, 1891, p. 16.

Definition. *Clitellum, XXV–XXXIII. Setae strictly paired, very delicate. First dorsal pore IV/V. Tubercula pubertatis on XXX, XXXI. Hab.—Jassy.*

This species has been described from a fragment, which wanted the hinder end of the body; hence no measurements can be given. The worm has no integumental pigment. On the tenth segment there are a pair of papillae on a line with the lateral setae.

(39) Allolobophora lissaensis, MICHAELSEN.

A. lissaensis, MICHAELSEN, loc. cit., p. 18.

Definition. *Length*, 55 *mm.; breadth*, $3\frac{1}{2}$ *mm.; number of segments*, 123. *Clitellum, XXIX–XXXVI. First dorsal pore XIV/XV. Setae in eight rows. Tubercula pubertatis on all of clitellar segment. Spermathecae, six pairs in segments V–VIII, X, XI. Hab.—Lissa.*

The setae are in eight rows, but are not separated by equal distances; the following is their arrangement:—i–ii > ii–iii > iii–iv. The irregular position of the spermathecae is due to the fact, that some of the pouches open anteriorly and others posteriorly; the first four open posteriorly on a line with seta 3; the fifth pair lies either in the ninth or in the tenth segment, in the first case against the hind wall of the segment; in one specimen these had an intermediate position projecting into two segments (cf. *A. complanata*, BEDDARD, **13**). The sixth pair opens by the front wall of the eleventh segment.

(40) Allolobophora leoni, MICHAELSEN.

A. Leoni, MICHAELSEN, loc. cit., p. 15.

Definition. *Length*, 90 *mm.; breadth*, 5 *mm.; number of segments*, 156. *Clitellum, XXIII–XXXVI. First dorsal pore, IV/V. Tubercula pubertatis, XXX, XXXII. Setae paired, the ventral median interval is less posteriorly and greater anteriorly than the lateral. Spermathecae, eight to ten in each of segments X, XI. Hab.—Jassy.*

This species is not very fully described by MICHAELSEN. Further details were added by ROSA (**15**). It is unpigmented, like *A. trapezoides*. The post-clitellian region of the body is angular; the segments of the anterior part of the body are tri-annulate. It appears to be uncertain whether the clitellum does not extend as far as to the thirty-ninth segment; ROSA, however, only found it to occupy xxvi–xxxiv. The ventral setae of segments xii, xiii, xxii lie on slightly raised papillae.

(41) Allolobophora jassyensis, MICHAELSEN.

A. jassyensis, MICHAELSEN, loc. cit., 1891, p. 17.

Definition. *Length*, 95 *mm.; breadth*, 4 *mm.; number of segments*, 133. *Clitellum, XXVIII, XXIX–XXXV. Tubercula pubertatis, XXXI–XXXV. Setae strictly paired.*

First dorsal pore, IV/V. Spermathecae in IX, X, opening between IX/X, X/XI. Hab.—Jassy; Palestine.

In the above definition I have, as usual, given the greatest length and the greatest number of segments of the individuals studied by the describer of the species. It is a remarkable fact that the smallest specimen, measuring only 58 mm. in length, had the largest number of segments, while the largest specimen had the fewest segments. The ventral setae of the segments x, xi, xiii, xxvii, are upon strongly marked papillae; these papillae appeared to be quite constant in the species. Only two pairs of sperm-sacs were found lying in xi, xii. According to ROSA two tubercula occupy xxxii–xxxiv, and the spermathecae are in x, xi. The sperm-sacs are four pairs.

(42) Allolobophora japonica, MICHAELSEN.

A. japonica, MICHAELSEN, Arch. f. Nat., 1892, p. 230.

Definition. *Length, 42 mm.; breadth, 2½ mm.; number of segments, 126. Clitellum, XXIV–XXXI. Setae strictly paired, separated by equal intervals. First dorsal pore, IV/V. Tubercula pubertatis, XXVII, XXIX. Spermathecae two pairs in IX, X, opening between IX/X, X/XI, in line with lateral setae. Hab.—Japan.*

Of this species there appear to be two varieties, which are only to be distinguished by colour and size. I have selected the smaller form for description as the type, for the reason that it comes first in MICHAELSEN'S account of *A. japonica*. This form is colourless; the larger worms are a darkish red in colour, and measure 130 mm. in length by a diameter of 5 mm.; the body is composed of 155 segments. In both forms the setae of the hinder end of the body are rather larger than those in front. There are besides the tubercula pubertatis several papillae; two pairs of these lie upon segments xxii, xxv. Those of the first segment are in line with the ventral setae, the second pair more dorsal in position.

(43) Allolobophora madeirensis, MICHAELSEN.

A. madeirensis, MICHAELSEN, loc. cit., 1891, p. 206.

Definition. *Length, 47 mm.; diameter, 5 mm.; number of segments, 135. Setae not strictly paired. Clitellum, XXXII–XXXVI. Tubercula pubertatis, XXXIII–XXXV. Dorsal pores begin III/IV. Hab.—Madeira; Portugal.*

(44) Allolobophora dubiosa, OERLEY.

Criodrilus dubiosus, OERLEY, MT. Akad. Math., xvi, 1880, p. 603.

A. dubiosa, OERLEY, Ert. termesz. Kör. xv, 1885, p. 24.

Definition. *Length,* 180 *mm.; number of segments,* 250. *Colour a dark, green reddish below; clitellum flesh-coloured. Setae strictly paired. Clitellum, XXXVII–XLVI. Hab.—Hungary; in marshy spots.*

This species, as will be evident from the above, is but ill-defined. Rosa (**15**, p. 55) considers that the tubercula pubertatis are in the form of a continuous ridge along the clitellum, which is referred to by Oerley, though the latter states that there are no tubercula. The position of the clitellum, however, coupled with the strictly paired setae seems to mark out the species as distinct.

(45) Allolobophora mediterranea, Oerley.

A. mediterranea, Oerley, Zool. Anz., 1881, p. 286.

Definition. *Length,* 120 *mm.; number of segments,* 120. *Setae strictly paired. Clitellum, XXIII–XXXI. Tubercula pubertatis on XXIX, XXX, XXXI. Hab.—Balearic Isles.*

(46) Allolobophora frivaldszkyi (Oerley).

Lumbricus terrestris, var. gigas, Oerley, MT. Akad. Math. xvi, 1880, p. 582.
Octolasion Frivaldszkyi, Oerley, Ert. termesz. Kör., xv, 1885, p. 17.

Definition. *Length,* 360 *mm.; diameter,* 20 *mm.; number of segments,* 260. *Setae distant:* 1–2 > 2–3 *and* 3–4. *Clitellum, XXVIII–XXXV. Tubercula pubertatis, $\overline{XXVIII–XXXV}$. Hab.—Hungary.*

(47) Allolobophora gracilis (Oerley).

Octolasion gracile, Oerley, Ert. termesz. Kör., xv, 1885, p. 18.

Definition. *Length,* 70 *mm.; number of segments,* 180. *Setae not strictly paired. Clitellum, XXX–XXXV. Tubercula pubertatis, $\overline{XXX–XXXV}$. Hab.—Hungary and Holland.*

This species is evidently, as Rosa (**15**, p. 63) suggests, near to *A. cyanea*. *Octolasion rubidum* of Oerley (**2**) is probably merely a variety of this species, as Rosa (**15**, p. 64) has pointed out. Its clitellum and tubercula are exactly the same in position and extent; it was met with in Hungary and at Woolwich. The prostomium is stated to be larger and to occupy two-thirds instead of one-half of the buccal segment, but no salient points of difference can be extracted from the description. As Rosa, who has had so much experience in this family, recognizes the species '*rubida*' (though as he points out its name will have to be changed) I prefer to leave the matter undecided.

(48) Allolobophora nasonovii, Kulagin.

Dendrobaena nasonovii, Kulagin (fide Rosa, **15**).

Definition. *Length,* 90 *mm.; number of segments,* 170. *Setae in eight rows. Clitellum, XXV–XXIX. Hab.—Suchum.*

This species is, as Rosa (**15**, p. 45) points out, close to *A. platyura;* but he holds it to be probably distinct; it is evidently but ill defined.

(49) Allolobophora bogdanovii, Kulagin.

A. Bogdanovii, Kulagin (fide Rosa, **15**).

Definition. *Length,* 662 *mm.; number of segments,* 110. *Setae distant. Clitellum, XXV–XXX. Tubercula pubertatis, XXVIII, XXIX, XXX. Hab.—Suchum.*

(50) Allolobophora caucasica, Kulagin.

Dendrobaena caucasica, Kulagin (fide Rosa, **15**).

Definition. *Length,* 40 *mm.; number of segments,* 90. *Colour dark red, darker above than below. Setae in eight rows, equidistant. Prostomium completely dividing buccal segment. Clitellum, XXV, XXVI–XXIX, XXX, XXXI. Dorsal pores commence IV/V. Hab.—Kacila, in the Caucasus* (2,200 *ft.*).

This is another doubtful form, of whose internal structure nothing is known.

(51) Allolobophora oerleyi, Horst.

Enterion platyurum, Fitzinger, Isis, 1833, p. 552 (in part.).

Lumbricus terrestris, var. **platyurus,** Oerley, MT. Akad. Math., xvi, 1880, p. 583 (in part.).

Octolasion platyurum, Oerley, Ert. termesz. Kör., xv, 1885, p. 18 (in part.).

A. Oerleyi, Horst, Notes Leyd. Mus., ix, 1887, p. 294.

A. platyura, var. **depressa,** Rosa, Mem. R. Acc. Torino, 1893, p. 44.

Definition. *Length,* 111 *mm.; number of segments,* 130. *Setae distant. Clitellum, XXV–XXX. Tubercula pubertatis, XXVI–XXVIII. Male pores inconspicuous. Spermathecae in VII–X, opening posteriorly by seta IV. Hab.—Europe.*

Horst found some variation in the number of spermathecae, there being sometimes only three or four pairs.

(52) Allolobophora fitzingeri, Beddard.

Enterion platyurum, Fitzinger, Isis, 1833, p. 552 (in part.).

Lumbricus terrestris, var. platyurus, Oerley, MT. Akad. Math., xvi, 1880, p. 583, (in part.).

Octolasion platyurum, Oerley, Ert. termesz. Kör., xv, 1885, p. 18 (in part.).

A platyura, var. typica, Rosa, Mem. R. Acc. Torino, 1893, p. 43.

Definition. *Length*, 111 *mm.; number of segments*, 153. *Setae distant. Clitellum, XXV–XXX. Tubercula pubertatis, XXVI–XXVIII, XXIX. Male pores inconspicuous. Spermathecae in X, XI, opening anteriorly by seta IV. Hab.—Europe.*

Rosa speaks of two varieties or subspecies—*typica* and *depressa*. The latter I place, as Rosa was inclined to think should be done, in a distinct species. The worms called '*platyurum*' by Fitzinger were found (by Wesseley) to consist of these two subspecies, to *both* of which the (imperfect) diagnosis of Fitzinger applies. The name of *A. oerleyi* must be applied to the species '*depressa*.' Accordingly, I propose to call this worm by the above name.

Genus LUMBRICUS, Eisen.

Definition. Prostomium completely divides buccal segment. Setae strictly paired. Longer, straighter setae on clitellum. A median seminal reservoir, extending through segments X, XI, present, into which open three pairs of sperm-sacs. Spermathecae always two pairs in IX and X.

Rosa recognizes (**15**, p. 22) eight species of the genus, which form a remarkably graduated series, in respect of the segments which bear the tubercula pubertatis. I repeat here the table which he gives in illustration of this:—

1.	(Variation of *L. rubellus*)	27, 28, 29, 30
2.	*L. rubellus*	28, 29, 30, 31
3.	*L. castaneus*	29, 30, 31, 32
4.	*L. meliboeus*	30, 31, 32, 33
5.	*L. tyrtaeus*	31, 32, 33, 34
6.	(Form wanting)	(32, 33, 34, 35)
7.	*L. herculeus*	33, 34, 35, 36
8.	*L. papillosus*	34, 35, 36, 37
9.	*L. festivus*	35, 36, 37, 38
10.	*L. polyphemus*	40, 41, 42, 43, 44, 45.

It will be observed that one form only is wanting to complete the symmetry of the first seven species, if, that is to say, we allow *L. tyrtaeus* of Savigny and *L. papillosus* of Friend.

(1) Lumbricus rubellus, Hoffmeister.

L. rubellus, Hoffmeister, Arch. f. Nat. 1843, p. 187.

Enterion rubellum, Oerley, MT. Akad. Math. xvi, 1880, p. 588.

L. (Lumbricus) rubellus, Vaillant, Annelés, p. 126.

Definition. *Length*, 120 *mm.; diameter*, 6 *mm.; number of segments*, 120. *Colour, red brown or purple. Clitellum, (XXVI) XXVII–XXXII. Tubercula pubertatis, XXVIII, XXIX, XXX, XXXI. First dorsal pore, VII/VIII. Male pores almost invisible. Hab.—Europe; N. America; Siberia; Nicobar; New Zealand.*

Rosa (**15**) describes the colour as 'bruno rossiccio.' In my New-Zealand examples it is distinctly purple, as in the next species. The clitellum, however, agrees with that of *L. rubellus*, rather than with that of *L. castaneus*.

(2) Lumbricus castaneus (Savigny).

Enterion castaneum, Savigny, Mém. Ac. Roy. Fr. Inst. (Analyse), v, 1826, p. 180.

E. pumilosum, Savigny, ibid., p. 181.

Lumbricus castaneus, Dugès, Ann. Sci. Nat. (2), viii, 1837, p. 22.

L purpureus, Eisen, Öfv. Svensk. Akad. 1871, No. 10, p. 956.

Definition. *Length*, 500 *mm.; diameter*, 4 *mm.; number of segments*, 90. *Colour chestnut or violet brown. Clitellum, XXVIII–XXXIII. Tubercula pubertatis, XXIX, XXX, XXXI, XXXII. First dorsal pore, VI/VII. Hab.—Europe; N. America.*

This species, like the last, has almost invisible male pores, owing to the absence of a glandular swelling, such as characterizes so many Lumbricidae. The prostomium has a transverse furrow, often (but not always) wanting in *L. rubellus*. It is apparently only to be distinguished by the different position of the clitellum and the tubercula pubertatis.

(3) Lumbricus meliboeus, Rosa.

L. meliboeus, Rosa, Lombr. Piemont., 1884, p. 21.

Definition. *Length*, 90 *mm.; diameter*, 5 *mm.; number of segments*, 124. *Colour violaceous,*

with a median darker streak posteriorly. Clitellum, XXIX–XXXIII. Tubercula pubertatis on XXX, XXXI, XXXII, XXXIII. First dorsal pore, VII/VIII. Hab.—Piedmontese Alps.

The spermathecae are stated to occur in segments viii and ix, which is, of course, an unusual position for them to occupy in this genus. The male pores are well-marked externally.

(4) **Lumbricus polyphemus** (Fitzinger).

Enterion Polyphemus, Fitzinger, Isis, 1833, p. 552.

L. Polyphemus, Dugès, Ann. Sci. Nat., (2) viii, 1837, p. 21.

Definition. *Length,* 180 *mm.; diameter,* 8 *mm.; number of segments,* 130. *Clitellum, XXXIX–XLV. Tubercula pubertatis, XL, XLI, XLII, XLIII, XLIV. Male pores almost invisible. Hab.—Austria.*

The above description is taken from Rosa's (**15**) definition of the species. The identification with Fitzinger's species is rendered certain by a comparison (Carl Wessely quoted by Rosa) with Fitzinger's type.

(5) **Lumbricus festivus** (Savigny).

Enterion festivum, Savigny, Mém. Ac. Roy. Inst. Fr. (Analyse), v (1826), p. 180.

L. festivus, Dugès, Ann. Sci. Nat. (2), viii, 1837, p. 21.

L. rubescens, Friend, Nature, 1891, p. 273.

Definition. *Length,* 100 *mm.; diameter,* 5 *mm.; number of segments,* 120. *Colour, bright red brown. Clitellum, XXXIV–XXXIX. Tubercula pubertatis, XXXV, XXXVI, XXXVII, XXXVIII. First dorsal pore, V/VI. Male pores with swollen lips. Hab.—England; France.*

(6) **Lumbricus papillosus,** Friend.

L. papillosus, Friend, P. R. Irish Ac. (3), ii, p. 453.

Definition. *Length,* 100 *mm.; diameter,* 8 *mm.; number of segments,* 130. *Colour, ruddy brown. Clitellum, XXXIII–XXXVII. Tubercula pubertatis, XXXIV, XXXV, XXXVI, XXXVII. First dorsal pore, IX/X. Hab.—Ireland.*

(7) Lumbricus herculeus (SAVIGNY).

Enterion herculeum, SAVIGNY, Mém. Roy. Ac. Inst. Fr. (Analyse), v, 1826, p. 188.

L. herculeus, DUGÈS, Ann. Sci. Nat., (2) viii, 1837, p. 21.

L. agricola, HOFFMEISTER, De verm. quibusd. 1842, p. 24 (in part.).

L. terrestris, EISEN, Öfv. Svensk. Akad., 1871, No. 10, p. 954.

Definition. *Length,* 360 *mm.; number of segments,* 180. *Clitellum, XXXII–XXXVII. Tubercula pubertatis, XXXIII–XXXVI. First dorsal pore, VII/VIII. Male pores conspicuous. Hab.—Northern Europe; N. America; Siberia.*

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INDEX OF GENERA AND SPECIES

*** The names printed in capitals and italics are synonyms or species incertae sedis. The figures in heavy type refer to the page on which the description of the species will be found.

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